POWER

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Deliver Us From Mediocrity

WE HAVE been through a period of commencements. Hundreds of young people, their institutional training completed, are going out into the world to make their living.

What will be the story, for them, that the next ten or twenty years will tell?

Can the opportunities offered by business and industry, by the needs of our growing civilization, fulfill the glowing hopes of the horde of aspirants for emolument and distinction?

The opportunities are here. There are still great things to be done in the world, and the things that have been done have made the doing of greater things possible and easy.

Among the graduates of 1927 there are doubtless some who are destined to large attainments; names that will live in the history of their epoch.

But the majority of them will slide into the level of the commonplace and make a more or less precarious living by following some routine job or a neighborhood or small-town practice.

And yet industry is calling for men who can do things. The Captains are looking for men who can appreciate what they are trying to get done and who will take hold with an intelligent heart-whole interest and do it.

For men to whom they can turn a thing over and forget it, confident that it will be well taken care of.

And the man who can grasp a situation of this kind and with initiative and resourcefulness bring about a realization of the ideals and purposes of his superior and do it so that it will stay done, is the man who will soon be giving orders in his own right.

The world is full of men who need direction, whose service is measured by time and not by real accomplishment; who could carry a Message to Garcia only if somebody routed them through and got their Pullman reservations.

Perfunctory service is the rule. To do a thing so that it will get by, rather than to do it with real craftsmanship, is the habit of the ordinary workman.

And half of the trouble and vexation and delay and expense attending the ordinary operations of industry and of life come from the breaking down of slipshod jobs done by mediocre workmen whose only object is to get them so that they will last until they get away.

Power Plant of the
Wolverine Shoe & Tanning Co.
Rockford, Michigan

By Burritt A. Parks

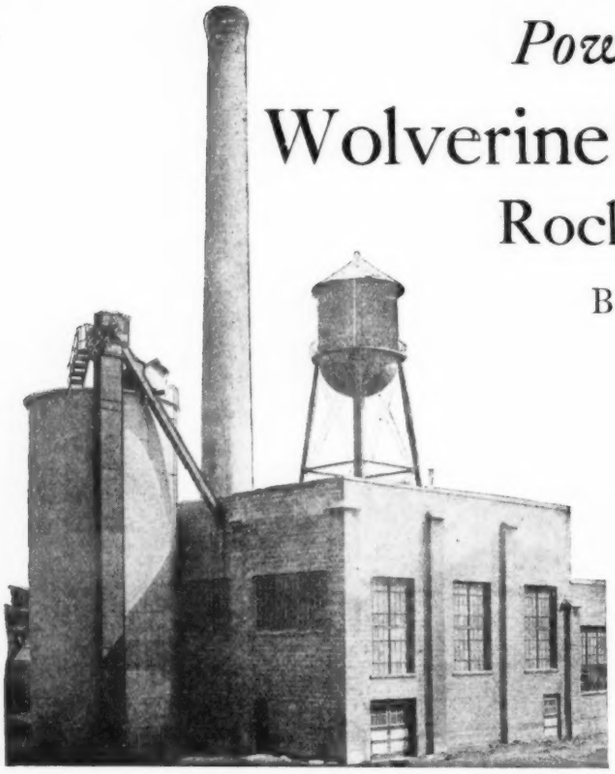


Fig. 1—Power plant and coal-handling equipment

PLANT supplies power, light, heat and process steam for manufacturing plant and serves as stand-by for village lighting. Two 350-kw. direct-current, single-cylinder uniflow engine-driven units operate condensing or non-condensing as dictated by process steam demands. Horizontal water-tube boilers fired by semi-automatic inclined-grate stokers and unit coal pulverizers.

IN 1922 the Wolverine Shoe & Tanning Corp. (then called the Hirth-Krause Co.), of Rockford, Mich., had so far outgrown its manufacturing facilities that a program of expansion was decided upon, including an entire new power plant. This concern manufactures shoes and gloves and tans its own leather.

The power plant, in addition to supplying power, light, heat and process steam for the tannery and shoe factory, is used as a stand-by plant for village lighting. There is a small hydro-electric plant on the Rouge River which supplies the domestic lighting current for the village, but during periods of low water the pondage is insufficient to carry the load the entire 24 hours.

When the shoe factory and tannery were built several years ago, 220-volt direct current was chosen for power and lighting purposes and, later, when electric lighting service was installed throughout the village, the same current was used in order that the tannery and shoe-factory power plant could be used as a stand-by for the hydro-electric development. When the design of the new plant was undertaken, consideration was given to changing from direct to alternating current, but it was decided that the cost of making the change was altogether prohibitive.

The capacity decided upon for the first unit of the new plant was 350 kw. There is considerable demand for exhaust steam, even in the summer time, for drying and heating water, consequently a non-condensing prime mover was desirable. The demand for exhaust steam for at least five months of the year would not equal that available from the prime mover, therefore economy of steam consumption was of prime importance. After careful consideration of the situation, a single-cylinder non-condensing uniflow type of engine was selected.

The boiler installation to serve the first generating unit consists of two 2,650-sq.ft. horizontal water-tube boilers. Underfeed forced-draft stokers were considered, but as a compromise on first cost semi-automatic inclined-grate stokers were installed in conjunction with an automatic unit-type of coal pulverizer. In operation a light fire is maintained on the grate and the particles of coal from the pulverizer not burned in suspension fall to the grate and are burned there.

Tests on the boilers have shown the average operating efficiency of boiler and furnace to be 65 to 70 per cent,

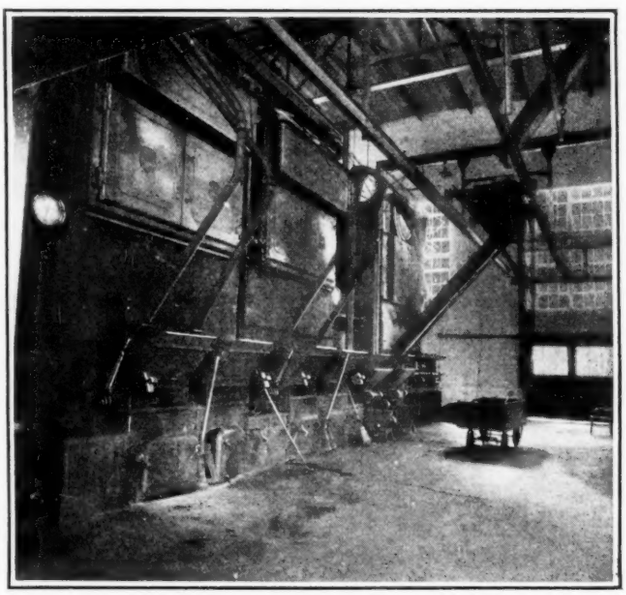


Fig. 2—Boilers are fired by semi-automatic stokers and unit pulverizers

although with favorable conditions somewhat higher efficiencies have been obtained.

Both the tannery and shoe factory are heated by vacuum systems of steam heating, all condensation being returned to the power plant by means of duplicate steam-driven vacuum pumps. The vacuum pumps discharge to an overhead air separating and surge tank and thence by gravity to an open-type feed-water heater. Boiler feed pumps are of the single-cylinder steam-driven type. All boiler feed is measured by a displacement-type hot-water meter placed below the feed-water heater from which the rate of flow to the meter and thence to the boiler feed pumps is controlled by a float and balanced valve in accordance with the demand. The selection of coal handling and storage equipment presented a problem as, on account of the comparatively small size of the plant, a large investment for coal-handling facilities would not be justified. After various systems had been considered, the one shown in Fig. 4 was finally decided upon. This installation consists of a track hopper and apron feeder discharging into a bucket elevator which, in turn, by means of a bifurcated discharge spout and valve, discharges either into storage or to the weigh larry in the boiler room.

The storage bin consists of a reinforced-concrete silo holding 400 tons of coal. Reclaiming is accomplished by means of a spout and gate discharging into the boot of the bucket elevator.

This coal-handling plant, while comparatively simple, has given good results. While the cost of unloading coal by hand under the old method was about 55c. per ton, the equipment just referred to unloads coal into storage for less than 35c. per ton, which includes interest on investment, depreciation, maintenance, attendance, and power required to operate. Most of this cost is made up of fixed charges, so that, as the amount of coal handled increases, the total cost per ton will decrease.

The power house, as will be seen from the illustrations is built of concrete blocks with steel trusses supporting the roof, steel sash and concrete floors. The engine-room walls are faced on the inside with salt glazed brick.

In the spring of 1925 the load had increased to such an extent that additional generating capacity was required and consequently it was decided to double the plant.

An additional 350-kw. generator direct-connected to a uniflow engine was purchased and also an additional boiler. On account of the fact that the demand for low-pressure steam had not increased as fast as the demand for electric power, it was decided to install condensing equipment. A surface condenser was chosen and the exhaust piping so arranged that either generating unit could be operated condensing and the other unit non-condensing. This arrangement gives good flexibility of operation and makes it possible to strike a close balance between low-pressure steam demand and exhaust steam available.

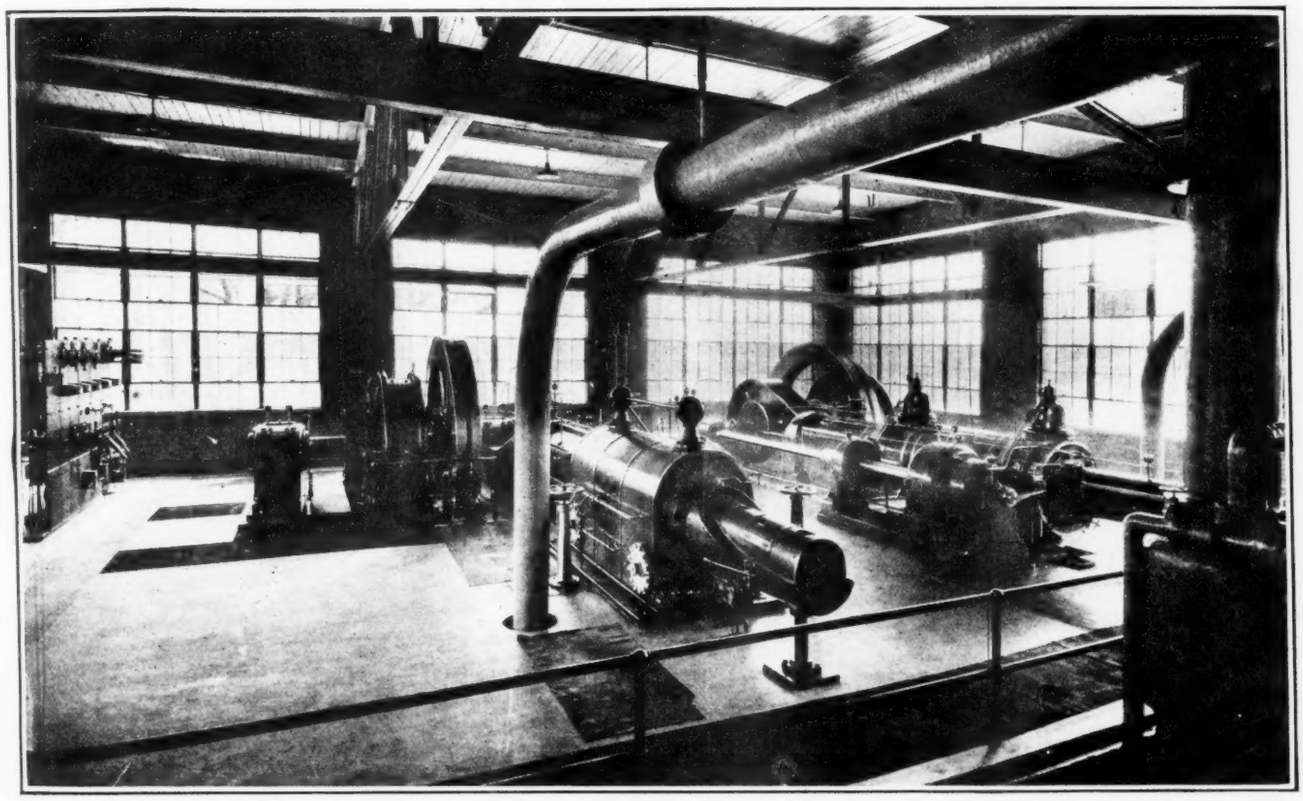


Fig. 3—The 350-kw. direct-current generators are driven by poppet-valve uniflow engines

Condensing water was obtained by damming a small creek about 200 ft. from the power house. A concrete settling basin with trash racks was constructed on the bank of the creek, and a motor-driven centrifugal pump takes suction from this basin as well.

As there is a large demand for warm water in the tannery, the condensing water is discharged to a concrete well from which point the warm water is pumped to the tannery, the excess overflowing to the sewer. This provision effects considerable economy in operation, particularly in the winter, as otherwise the exhaust from

one engine would not supply the low-pressure steam demand. The high- and low-pressure steam lines and electric feeders are carried from the power plant to the tannery on steel towers. The engineering work was done by Byron E. Parks & Sons, consulting engineers, Grand Rapids, Mich.

COST OF THE COMPLETE POWER PLANT, AND THE MECHANICAL EQUIPMENT INSTALLED

Building—Including machinery foundations and 7x150-ft. reinforced-concrete chimney	$33,800
Boilers—Two 2,650-sq.ft. Heine and one 3,000-sq.ft. Union horizontal water-tube boiler, delivered and erected ready for brickwork	19,860
Generating units—Two 22x36-in. heavy-duty Hamilton poppet-valve uniflow engines direct connected to Ridgway 350-kw., 240-volt direct-current generators, delivered and erected	35,700
Stokers—Two McClave-Brooks and one Auburn semi-automatic inclined-grate stokers, delivered and erected	4,850
Coal pulverizers—Three Newcomb automatic coal pulverizers and feeders, delivered and erected	3,000
Coal-handling equipment—One 20x50-ft. reinforced-concrete coal storage silo, track hopper, bucket elevator, apron feeder, motors, 1,000 lb. weigh larry, foundations, etc.—Erected complete	8,500
Condensing equipment—One Worthington 866-sq.ft. surface condenser; one 5-in., 450-g.p.m. Worthington motor-driven centrifugal circulating pump; one 2-in., 25-g.p.m. Worthington motor-driven centrifugal hotwell pump; one 7½x6-in. motor-driven rotative dry-vacuum pump. All delivered and erected	3,925
Boiler feed and vacuum return pumps—Two 12x7x12-in. Burnham steam-driven plunger boiler feed pumps; Two 8x10x12-in. Burnham steam-driven vacuum pumps, delivered and erected	1,600

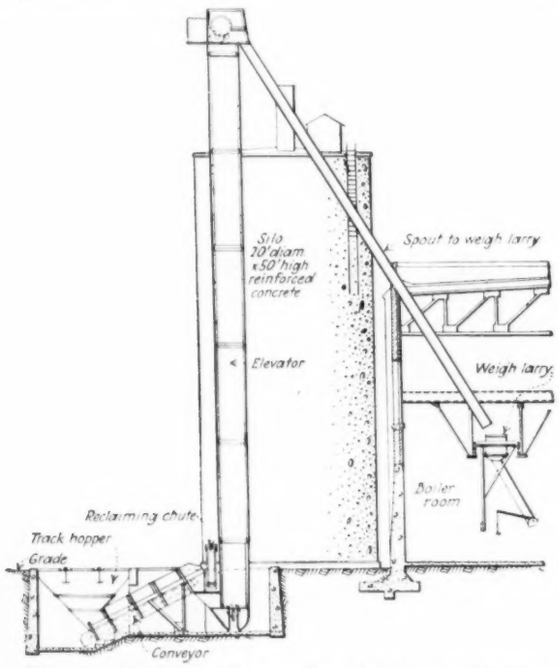


Fig. 4—Coal handling and weighing equipment

Feed-water heater—One 35,000-lb. Hoppes open-type horizontal-pattern, installed	1,675
Feed-water meter—One 35,000-lb. Central Station Steam Co. displacement type meter, installed	600
Piping, steam specialties, etc., installed	14,050
Condenser circulating pump suction (6-in. C. I.) and discharge (10-in. tile)	1,750
Pipe covering	2,375
Breeching—No. 10 gage steel with 3x2-in. angle stiffeners, erected	1,280
Soot blowers, installed	1,300
Switchboard and electric wiring	6,000
Total	$140,715
Cost per installed kilowatt	$200

What Do You Know?

The answers are on page 125

IT IS unfair, both to the editor of this column and to the reader, to expect too much gray-matter action during vacation weather. So the ten questions below are intended to require the minimum of energy in the answering; at least the questions were produced without the expenditure of a single B.t.u. The answers did not come so easily, but are they correct? If you do not think so, declare yourself.

Ques. 1—What is meant by the specific viscosity of a lubricating oil?

Ques. 2—Is the thermal or indicated efficiency of a Diesel greatest at full load or at some partial load? Why?

Ques. 3—Why must the tail pipe of a barometric condenser be submerged in a hotwell or water receptacle?

Ques. 4—For what is the Pensky-Martens tester used?

Ques. 5—What causes side wear on motor brushes?

Ques. 6—What limits the maximum possible length of turbine blades?

Ques. 7—How can you change the lead on a uniflow engine?

Ques. 8—For strength, must an overhung crank have greater proportions than a center crank?

Ques. 9—What would be the result of the ends of the vanes of a centrifugal pump being cut off?

Ques. 10—When was the basic Curtis turbine patent granted?

TO MEET SUDDEN LOAD DEMANDS and to guard against equipment failures, many power companies maintain immense storage batteries to handle the load during the few minutes that are sometimes required to bring the generating machinery up to speed. These batteries usually are the largest to be found anywhere—some weighing over three tons per cell. Some plants keep as much as 500 tons of batteries always standing ready for service. There are some eighteen cities in the United States and Canada in which stand-by batteries are employed for emergency service. In five representative cities of this class there are 125 of these batteries aggregating in capacity 675,000 amperes at the one-hour discharge rate at the 250 volts. These batteries would, therefore, carry the load of 2,700,000 sixty-watt incandescent lamps for one hour.—*A.I.E.E. Journal.*

Changing Transformer Voltage

By K. A. Oplinger

Transformer Engineering Department, Westinghouse Electric & Manufacturing Company

UNTIL comparatively recently, transformers were designed for a single ratio. Then the use of one or more taps in the winding was provided, which allowed changing the connections to vary the ratio. This was followed by the introduction of manual switching arrangements for readily changing from one tap to another without load on the transformer. The final development has been equipment for changing the ratio of transformers while under load and the control arranged so that the voltage may be regulated by an operator through a remote-control system or made completely automatic and responding to voltage changes on the low-voltage side of the transformers. In this article some of the latest developments in tap-changing equipment are described.

DEVELOPMENT of equipment for changing the voltage ratio of power transformers under load has resulted from the demands for an economical method of regulating and transferring large blocks of power from one part of a system to another. Its practicability and the need for this equipment have been demonstrated by the 1,500,000 kva. of transformer capacity now in service, provided with such means. The familiar single-winding method of changing taps under

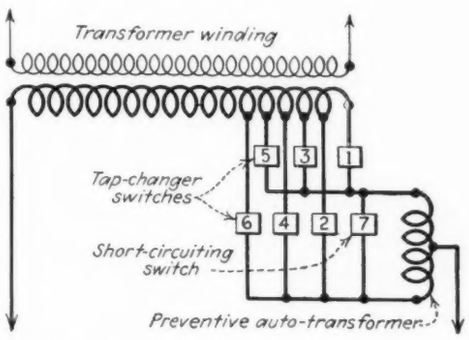


Fig. 1—Single-winding method of tap changing with short-circuited preventive auto-transformer

load, which switches a preventive auto-transformer or reactor along taps in the main transformer winding, has the inherent advantage of a minimum number of switch operations to change from one voltage position to the next. Fig. 1 shows a diagram of this method as applied to a transformer winding.

On position No. 1, Fig. 1, switches 1 and 7 are closed and switches 3 to 6 are open. This connects all the main secondary winding in circuit and short-circuits the auto-transformer. On position No. 2 switch 2 is closed and 7 is opened, an operation that connects the auto-transformer across the section of main winding between 1 and 2 and gives a voltage position midway between these taps. The third point on the tap changer is obtained by opening switch 1 and closing switch 7. From this it will be seen that only two switch operations are required to change from one voltage position to the next, and the voltage positions midway between taps are obtained by bridging

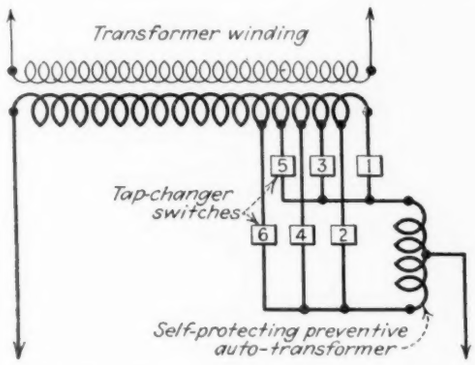


Fig. 2—Single-winding method of tap changing with self-protecting auto-transformer

the auto-transformer across taps and connecting to the mid-point of the auto-transformer winding.

In changing from one voltage position to the next, one-half of the preventive auto-transformer carries the full-load current of the main transformer. However, this is only momentarily, as the auto-transformer is either short-circuited or bridged across taps so that in the final voltage position each half of its winding carries half of the full-load current.

Overloading Winding Objectionable

The fact that a portion of the winding is overloaded for a short period is objectionable, as protective equipment is required to indicate that an abnormal condition exists and to give an alarm or remove the transformer from the line in case the winding remains overloaded due to a failure of the tap changing equipment. The design of a self-protecting preventive auto-transformer has removed the need of protective equipment as outlined in the foregoing, and the number of switch operations is reduced so that the opening or closing of a single switch changes the voltage ratio of the transformer. A diagram for this preventive auto-transformer method is given in Fig. 2. On position No. 1 with switch 1 closed, one-half of the preventive auto-transformer carries the load current of the main transformer. The change from voltage position No. 1 to voltage position No. 2 is made by the single operation of closing switch 2.

In this second position of the tap changer each half of the preventive auto-transformer carries half of the load current of the main transformer, and the voltage obtained is equivalent to a voltage midway between taps. The resultant current in the halves of the auto-trans-

former will be the vector sum of the exciting current of the auto-transformer and one-half the load current.

The switching cycle as given herein is repeated throughout the entire range of taps. As a switch is opened only on each alternate voltage position, two voltage positions are obtained for each switching cycle, which is a relatively light duty for tap-changing service.

A slight inequality in voltage steps is found in changing from one voltage position to the next, due to the change in reactance on alternate positions. This reactance difference during the switching cycle is an inverse function of the circulating current which is present when the auto-transformer is connected across adjacent taps, and is controlled by the use of suitable air gaps in the core of the auto-transformer. By this means the reactance variation may be reduced to a minimum, so the voltage difference is small and not objectionable.

In an actual installation the preventive auto-transformer may conveniently be mounted in the same tank as the main transformer, as in Fig. 3, which shows the core and coils of a 12,000-kva. transformer with a preventive auto-transformer *A* supported directly from the top end-frame.

The design of a circuit interrupting switch for tap-changing service is similar in many respects to that of an oil circuit breaker. However, the standard circuit breaker is not particularly adaptable to this type of service, as the number of operations made by a tap-changing switch will usually be much greater than is required of the average oil circuit breaker. Furthermore, a switch for tap-changing service does not require the large interrupting capacity of a circuit breaker, as the former either opens or closes on paralleled circuits at the transformer tap voltages and does not interrupt many times normal current at line voltages, as in the case of the standard breaker.

Advantage of these requirements has been taken in the design of a special switch, Fig. 4, which may be used for the lower current ratings. The contactors, in the upper part of the figure, are of the rolling and sliding type with hard-drawn copper-to-copper contacts. This type of contact is well adaptable where contactors are required to operate frequently under load.

The stationary and moving contacts are mounted on the ends of condenser bushings which support and insulate the switch. Owing to the shape of the contact surfaces, the tips engage first as the contactors close and then roll down to the heel, which is the current carrying part of the contact. Upon opening, the contacts will roll back and separation is made at the tips. With this type of construction the arcing takes place at the tips, leaving the heel clean and smooth for carrying current. The rolling action and the small amount of sliding that occurs also aid in keeping the contact surfaces clean.

The moving contactor is operated by an insulating rod, which in turn is connected to a cam-operated toggle mechanism. A double cam operates the toggle mechanism to insure positive opening and closing. In case the toggle mechanism should for any reason fail to open the switch, the cam will force the opening. The switches operate in a single oil compartment which is attached to the side of the transformer tank at *A*, Fig. 5. The oil in this compartment is separate from that in the transformer, and oil-tight seals on the bushings prevent any exchange of oil.

The tap-changer mechanism is directly beneath the switches and a heavy driveshaft connects the two units, as shown in the lower part of Fig. 4. This mechanism may be divided into three main parts—the motor and brake, the reduction gears and the control. A handwheel on each mechanism provides for manual operation of the tap changer in case of emergency.

In addition to a mechanical position indicator on each

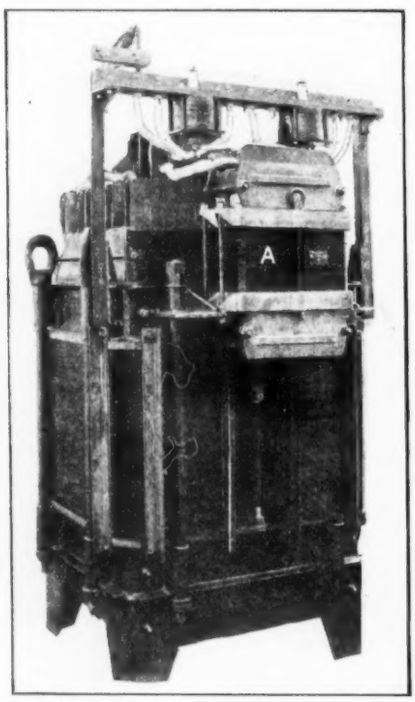


Fig. 3—Preventive auto-transformer shown at A

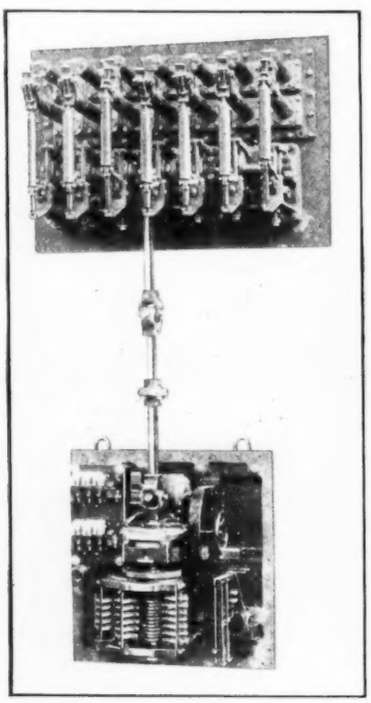


Fig. 4—Tap-changing special switching equipment

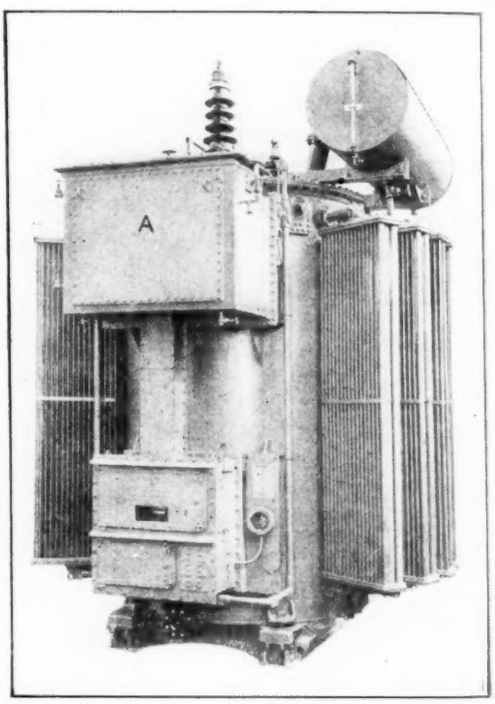


Fig. 5—Tap-changing switch mounted on transformer at A

mechanism, a remote electrically operated indicator is provided, so an operator at the control switchboard may determine the position of all tap changers and observe the tap-changing operation.

In cases where differential protection is used on the main transformer, provision is made for switches on the tap-changer mechanism to change taps on the auto-balance transformer with each change in voltage ratio. This arrangement automatically keeps the currents balanced in the differential protective system and permits a close adjustment on the protective relays.

In a three-phase transformer bank composed of single-phase units, the tap changers are operated simultaneously by a single control switch. When a change of taps is once started by an operator, the equipment automatically completes the change.

Automatic Control

The operating requirements to be met by tap changing under load equipment on transformers used for bus regulation has naturally led to the use of automatic control. The first installation of automatic control on step-type tap changers was applied to six 12,000-kva., single-phase transformers. These transformers operate in two three-phase banks with 132,000-volt star-connected high-voltage windings and 11,500-volt delta-connected low-voltage windings. Equipment for changing taps under load covers a 20 per cent range of taps in the grounded neutral end of the high-voltage winding. Five 4 per cent taps are provided in this winding to give ten 2 per cent voltage steps when used with a preventive auto-transformer.

The control of the tap-changer mechanism is normally automatic in response to voltage changes on the low-voltage side of the transformer. If the voltage varies from a set normal for a given time, the tap changer automatically moves in one direction or the other to bring the voltage back to normal.

Voltage regulating relays, as normally used for automatic voltage control of induction feeder regulators, are used to initiate the automatic control equipment. These relays are adjusted to operate on voltage changes to which the tap changer must respond. With two relays a wide voltage range may be covered by adjusting one relay to operate on the voltage at which the tap changer should lower the line voltage and adjusting the other relay to operate on the voltage at which the tap changer is to operate to raise the line voltage.

Motor-Driven Time Relay

To eliminate unnecessary tap-changing operations which might result from line fluctuations of short duration, a motor-driven timing relay insures a positive time delay. This time delay is adjustable to meet the operating requirements of the system and prevents any tendency of the tap changer to raise the voltage in case of a short-circuit on the system which would reduce the voltage. When the relay is set for a given time delay, a change in voltage must exist for a fixed time before the tap-changer mechanism will operate to bring the voltage back to normal. If changes in the system voltage are not of sufficient duration to permit the motor-operated timing relay to close its contacts, the timing relay returns to a reset position.

Each transformer bank has separate automatic control equipment, but when the two banks operate in parallel, both banks are controlled by one set of control relays. Both transformer banks can be controlled from either set of relays, the set to be used being determined by the position of two control switches on the control panel. The operation of two transformer banks in parallel is then exactly the same as for only one bank.

To guard against operating the two transformer banks in parallel upon different taps, a lockout relay will operate under this condition to prevent further automatic operation of both banks and to give an alarm signal.

To insure that false operation does not occur due to accidental grounds on the control circuit, the control switches are provided with a large number of contacts which are inserted in the automatic and manually operated control circuits.

Answers to What Do You Know

The questions are on page 122

Ans. 1—The specific viscosity of an oil is its absolute viscosity compared to the absolute viscosity of water at the same temperature. Absolute viscosity is measured by the force required to overcome the frictional resistance of a plate moved parallel to a lower plate by an oil film of a thickness t, or

$$Absolute\ viscosity = \frac{Force \times film\ thickness}{Plate\ area \times velocity}$$

Ans. 2—The thermal efficiency is best at light loads. In the Diesel the efficiency is

$$E = 1 - \left(\frac{1}{R}\right)^{Y-1} \frac{(P^{Y-1} - 1)}{Y(P-1)}$$

when P is the cutoff ratio, R is the compression ratio and Y the ratio of specific heats. As P, the cutoff ratio, which decreases with a decrease in load, is increased, E, the efficiency, decreases.

Ans. 3—If not submerged, the entrance of air to the tail pipe would destroy the vacuum in the condenser head.

Ans. 4—This instrument is used to test the flash point of oil.

Ans. 5—Wear may be due to movement of the brushes brought about by a rough commutator. Lack of a pigtail, or shunt, may cause arcing, resulting in wear.

Ans. 6—It has been stated by the prominent turbine designers that the length limitation is set by the strength of a blade as a cantilever beam to support the weight of a man; in erection work it is a habit for the workman to stand on the blading.

Ans. 7—Either by shifting the position of the cam lifting the valve or by decreasing the clearance between cam and lifting mechanism, if the clearance be large.

Ans. 8—Yes. The load must be supported by a single bearing, the crankpin acting as a cantilever, while in center-crank engines the effect is a beam supported at each end and loaded at the center.

Ans. 9—The vane diameter would be decreased, which at constant r.p.m. would result in a decreased vane velocity, and consequently, a decreased water velocity. The head against which the water could be delivered would be lower, as this is based on the hydraulic formula $V^2 = 2gh$.

Ans. 10—On Sept. 1, 1896, the first Curtis patent was issued by the United States, and at the same time similar patents were issued by other governments throughout the world.

Management of Industrial Power*

By Walter N. Polakov

THE aim of this paper is to present a logical outline for an executive inquiry into an industrial power problem. To get an adequate answer, one must be able to formulate a sensible question. Likewise to become properly informed, one must secure necessary and sufficient answers. It is easier to answer than to ask; the task of an executive is, therefore, not an easy one. Soundness and success of executive direction depends upon the information he gets.

An executive need not be a power engineer if he can secure expert advice, but he must translate into action the knowledge of the best practice. It is essential that an executive, controlling industrial power, be at all times reliably informed as to: (a) What his plant can do; (b) what his plant does; (c) if it does not, why? The questions, grouped under several general heads, to which an executive must have reliable answers are listed as follows:

Is the capacity of his plant greater than, equal to or less than the requirements?

If capacity is greater than requirements, what is to be done with the excess capacity: (a) Scrap; (b) secure outside load; (c) carry on profit and loss account? If capacity equals requirements, how to provide for: (a) Breakdowns and maintenance; (b) peaks and unusual loads; (c) future growth. If capacity is less than requirements, how to secure additional power by: (a) Elimination of waste or staggering peaks of consumption; (b) purchase power; (c) enlarge installation.

Is the realizable efficiency of his plant greater or equal to the performance efficiency? If performance-efficiency is equal to set task of realizable efficiency, what are the conditions: (a) Operating practice; (b) maintenance; (c) labor compensation; (d) load? If performance efficiency is less than the task of realizable efficiency, are the causes: (a) Poor operation; (b) neglected maintenance; (c) fatigued, unskilled or disgruntled men; (d) unusual load?

Is the performance cost greater, equal to or less than the predetermined standard cost, based on task efficiency and standard prices for fuel, labor and supplies (fixed charges are treated separately)? If the performance-cost is greater than the standard realizable cost, is it due to: (a) Efficiency below the task; (b) market prices increase over standard? If the performance cost is equal to standard cost, is it not due to simultaneous: (a) Efficiency below the task; (b) market drop of prices; (c) proper performance fulfilled? If the performance cost is less than the standard cost is it due to: (a) Task set too low and was exceeded; (b) price reduction on fuel or labor or supplies, or both?

The performance cost of generated power may be greater, equal to or less than the price of purchased power. If the performance cost is smaller or equal in price to purchased power, then:

a. Is the plant so old and unsafe that it should be abandoned?

b. If so, is it possible to replace it wholly or in part to compete with outside power?

c. Is the plant so unreliable as to interruptions that outside power may be more dependable? If the performance cost is greater than the cost of purchased power:

a. May the plant be totally discarded?

b. Shall steam for heating and processing be generated; if so, at what cost?

c. Is the outside supply of power free from interruptions?

d. What do production losses amount to due to failure of power, such as overhead, ownership expense, spoilage due to interrupted process, lost wages, added hazard, etc.?

Is the cost of power correctly allocated to:

a. Forms of power used, such as: (1) High-pressure steam; (2) low-pressure steam; (3) exhaust steam; (4) steam power (shaft drive); (5) pneumatic power; (6) hydraulic power; (7) refrigeration; (8) transportation; (9) electric power; (10) electric light, etc., etc.?

b. Application of power, distributed: (1) By departments; (2) by grades of product; (3) by kinds of product?

The work outlined can be done for an executive by a competent power engineer, provided that he is not interested even subconsciously in:

a. Setting tasks too low to protect operating force from criticism;

b. Setting standard cost too low, attempting to assure employment;

c. Setting task too high to boost the design and construction of equipment;

d. Setting standard cost too high favoring purchase from outside. Competency of a task setter in an indus-

THE executive head of an industrial concern seldom thoroughly understands the problem of his power plant. If costs are high, he may not be able to ascertain where lies the trouble or to dissect the cost sheet and arrive at a reasonable conclusion as to how and where reductions may be made. This paper is valuable for the straightforwardness with which the author has gone into the heart of the problem. As the executive's time is usually so filled as to prevent devotion to long discussional papers, this paper is written in the form of an outline, containing the essential factors to be employed in a power-plant study.

*Paper presented at Spring Meeting of the American Society of Mechanical Engineers, White Sulphur Springs, W. Va., May 27, 1927.

trial power plant must also cover the adjoining fields of:

a. Technology of processes requiring power;

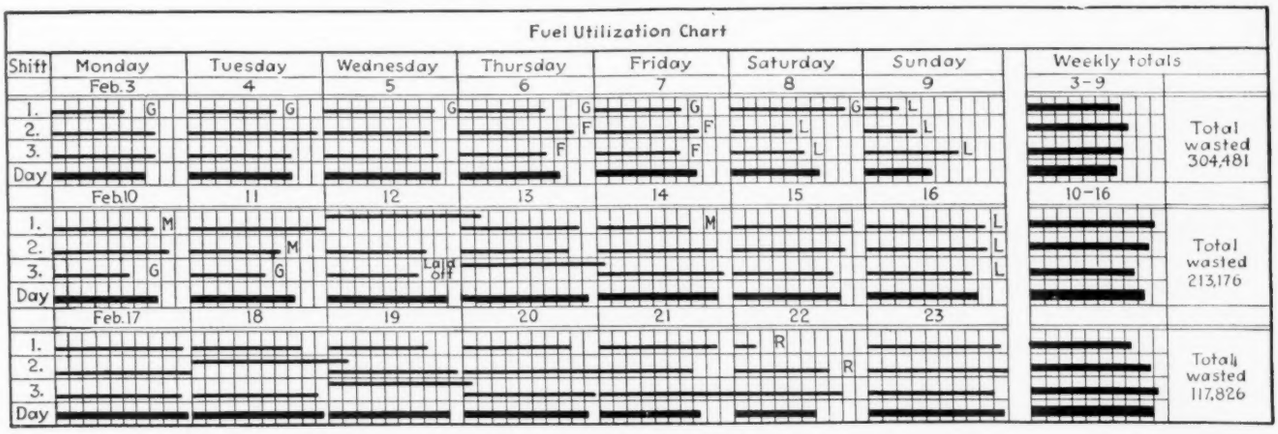
b. Economics and factory accounting;

c. Psychology and the rôle of "human element" in industrial problems.

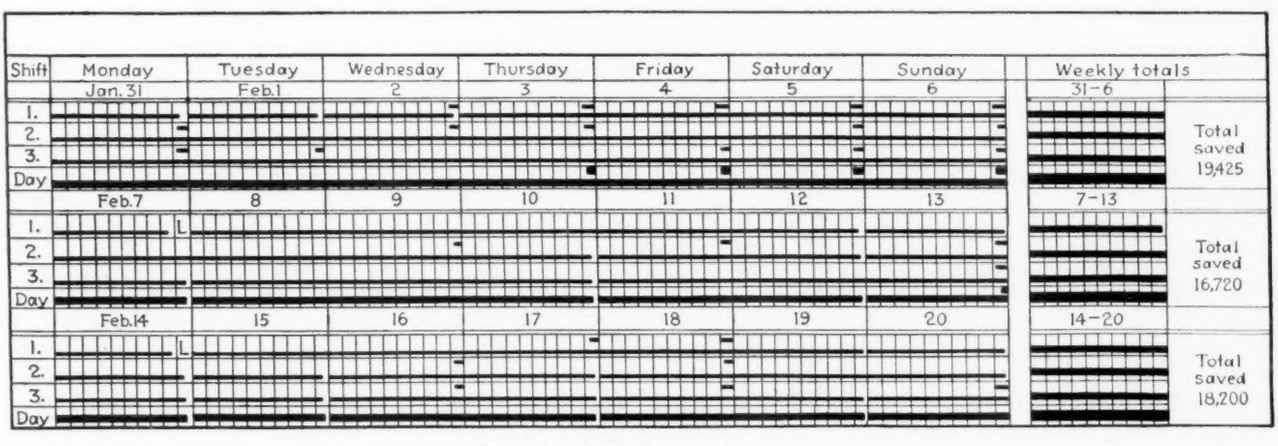
An executive must be informed continuously, adequately and reliably as to comparison of *what was done* with *what should have been done.* This information must be presented to an executive in a form ready to indicate action. Analysis of a mass of details consumes time and distracts attention. Therefore, information to the executive must clearly state whether the task was done—if not, *why not.*

To meet this requirement of comparing actual facts with desired, we make pictures of facts such as plant logs, cost sheets and progress graphical charts. The chart pictures the fact in logical space. It is a model of reality. The extent of a bar on the chart is the extent of the accomplishment. The extent of the space for the period recorded is the extent of the desired fulfillment. Thus the performance chart is linked with reality. The extent of accomplishment on the scale of predetermined task is a logical picture of performance.

The illustration shows a form that serves the purpose effectively. The length of each daily space represents on the chart the task set for any operation. It might be in terms of required pounds of steam evaporated per pound of fuel used, the per cent of boiler plant efficiency, pounds of fuel per kilowatt-hour generated, pounds of steam used by turbine plant per kilowatt-hour, the number of boiler tubes turbined or the number of condenser tubes ferruled. The straight bars drawn for each shift of a day are shorter if performance falls short of the requirements and are equal to or extend beyond the daily spaces if the task set was met or exceeded. From such a chart the executive sees whether the plant is doing as well as it can or not. If not, his question is, why not? At the end of each short bar he sees a symbol, by which the operating engineer denotes the cause of the failure to live up to the task, as, for instance: *G* means "green operator"; *R* means "repair needed;" *F* means "fuel causes trouble;" *L* means "load unfavorable" and *M* means "man inattentive." Being informed what the plant does as compared with what it can do, an execu-



Record During Training Period



Record During Following Year

Chart used by the author to picture a plant's performance

tive may call the chief engineer into conference to discuss what measures must be taken in order to prevent in the future the recurrence of falling short of the task performance.

The next step for the executive is to know how much his power costs. Mere accountant's figures of power cost are meaningless, since under various load conditions expense would vary. It is advisable, therefore, that the executive have a report prepared for him in a graphic form. A chart is easily prepared picturing the relation of actual cost of power to the predetermined standard cost of power. When dollar and cents costs per unit rise, it does not necessarily mean worse operation, as this may be due to conditions beyond operating control.

To translate the knowledge of failure into an act of improvement is the job of an executive. Assuming the

knowledge of the best operating *method* and *means* for doing a good job as given, the variable is the *will* to apply knowledge to means. The job of an executive, therefore, is to stimulate the will to do better. The first step in this direction is to establish a goal, the point to strive at, to set *the task*. The second step is to make this striving for perfection *fascinating*. The third step is to offer an additional reward to those who learn; that is, pay a *bonus*. Avoiding failures is more important than correcting them; training is more important than discipline.

Operating a Solid-Injection Diesel

By John Skeoch

OPERATORS of solid-injection Diesels encounter problems peculiar to this type of engine and, until they have had considerable experience, may not understand the causes and remedies for such troubles. In my experience with four-stroke-cycle solid-injection Diesels using spring-loaded spray valves, I find that smoking at the exhaust and cylinder knocking are the least understood.

There is no doubt that one of the most annoying evils to contend with in this class of engine is smoking. The exhaust pipe may emit either white or black smoke, the latter being more in evidence.

White smoke is caused by too much air and occurs mainly when the engine is lightly loaded and the intake air is cold. It is easily stopped by partly closing the air inlet to the cylinder, so that less air is drawn in.

Black Smoke More Troublesome

Black smoke is more troublesome as it may be caused in many different ways and consequently it is much more difficult to locate the cause. At times this smoke is a result of insufficient air being supplied to the cylinders and a portion of the fuel injected cannot be burned and is passed off through the exhaust as unburned carbon particles.

The lack of air may be due to some restriction in the air-supply line, possibly where there are sharp bends or elbows. Any dust drawn in with the air has a tendency to lodge in these bends and in time may reduce the effective area of the inlet pipe. The grid or gauze usually fitted on these pipes is seldom sufficient to prevent fine dust from entering with the air, and if the engine room is dusty or the air full of lint, the gauze may choke up.

If the fuel-injection pressure is too low, the oil in its passage through the sprayer nozzle is not properly atomized and so is not in a condition to burn readily, consequently a portion of the fuel passes through the engine in a partly vaporized state and smoke appears. The fuel pressure depends upon the area of the atomizer or spray nozzle and if openings in the top are too large a suitable atomizing pressure cannot be maintained and the oil blows out under a low pressure.

Too much lubricating oil supplied to the cylinders may also cause smoking.

At times one hears knocks in the engine due to mechanical misadjustments. In an engine where the spray or injection valve is mechanically operated, the packing of the valve stem becomes hard and tight, holding the stem so that the valve cannot return to its seat after being raised by the cam and oil enters the cylinder after the valve should have closed. This will not do any damage during the exhaust and intake strokes, but on the compression stroke the charge is fired as soon as the temperature of compression reaches the flash point of the oil, irrespective of the position of the crank. As this point is reached some time before the crank is at top center, the result is a premature explosion which puts a severe strain on the engine. The defective cylinder should be cut out until the spray valve is operating properly.

The weakening or breaking of the sprayer valve spring will have the same result.

Another point which has some bearing on the smooth running of the engine is the equal loading of the cylinders. This can be ascertained by taking indicator diagrams from the cylinders. Another method usually employed, which gives a fairly good idea of the action of the cylinders, is to open the test holes in the exhaust connections and note the color and sound of the released gases.

The Engineer Should Know the System

Any engineer will readily understand the importance of efficient lubrication, as an engine will not run many minutes if the system fails. The engineer ought to know the system well enough to be able to locate a fault at once, possibly even to foresee trouble before it happens. Some makers install controls on their engines to shut off the oil supply to the fuel pump if the lubricating system fails.

Water-cooling arrangements give little trouble, but as a precaution in case of a leak it is advisable, before starting, to turn the engine by hand for two revolutions with the indicator cocks open to make sure the cylinders are clear of water. No attempt should be made to start if there is a leak or if the water system is charged with air, as there is a possibility of steam locks forming in the water space.

If, when starting the engine, combustion does not take place in a reasonable number of revolutions, it cannot be forced by prolonged operation on air; the only result will be a loss of starting air. The difficulty is generally quickly found. The fuel valve from supply may be closed. There may be air pockets in the fuel supply line or in the fuel pump and the spray valves may be empty. The temperature may be too low for ignition, owing to the cylinder air leaking past the valves, valve housing joints or piston rings.

This covers a list of troubles that the engineer may run against at one time or another. In looking them over, one will find there is nothing so serious or complicated that the average engineer cannot solve the difficulty.

Electric Power Companies Have Grown to such a size in the United States that there are now eighteen whose annual output of energy exceeds one billion kilowatt-hours annually. At the head of the list is the Buffalo, Niagara & Eastern Power Corporation, whose output in 1926 was 4,464,000,000 kw.-hr. This immense volume of power was generated principally by water at Niagara Falls. The Commonwealth Edison Co., of Chicago, is second and the Edison United and allied companies of New York City third. The Southern California Edison Co. is fourth and the Pacific Gas & Electric Co. fifth. There are no less than 126 systems in the United States each is generating more than 100-million kilowatt-hours a year.—*A.I.E.E. Journal.*

Water-Cooled Furnaces*

By Howard W. Leitch

General Superintendent of Power Plants, The United Electric Light & Power Company

TO THOMAS E. MURRAY must unquestionably go the credit for originating and successfully applying the water-cooled furnace. The embryonic idea that was evidenced in some of the early types of boilers wherein certain portions of their surface was extended into or along the sides of the furnace was never successfully developed and lay dormant, neglected and forgotten during a long span of years. Its failure was the result of insufficient knowledge of the circulation of the water in the boiler, and like a great many other such ideas its initial failure doomed it because the need for it was not sufficiently urgent to demand further trial.

With the advent of large furnaces of recent years, however, conditions changed. The broadened expanses of exposed surfaces in the furnace subjected to high temperatures and severe service of higher ratings presented an acute problem of high maintenance charges that called forth the ingeniousness of many inventive minds. The problem now involved the savings of large sums of money. It was no longer one of merely placing boiler surface more advantageously in relation to the fire. The entire line of effort that resulted was directed toward reducing the upkeep cost of the furnace refractories. The generic idea of Mr. Murray, however, was not to reduce the upkeep cost of the refractories, but to eliminate the refractories entirely.

The first water-cooled furnaces were installed on boilers Nos. 51, 52 and 53 in the Hell Gate Station of the United Electric Light & Power Co. in New York. These are Springfield horizontal-tube, cross-drum boilers and are fired by Taylor stokers. The boiler proper contains 15,500 sq.ft. of surface and the furnace volume is 6,500 cu.ft. The two side walls are formed of fin tubes for water cooling, so constructed that the fins that are welded on diametrically opposite sides of each tube overlap the fins of the adjacent tubes and thus form a continuous metal surface, 400 sq.ft. in area.

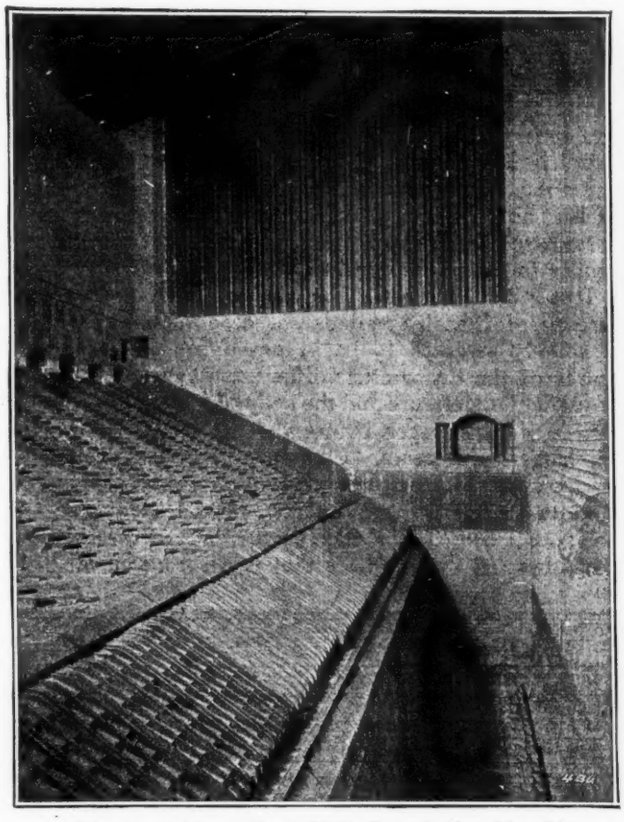


Fig. 1—Side wall of Hell Gate boiler No. 51

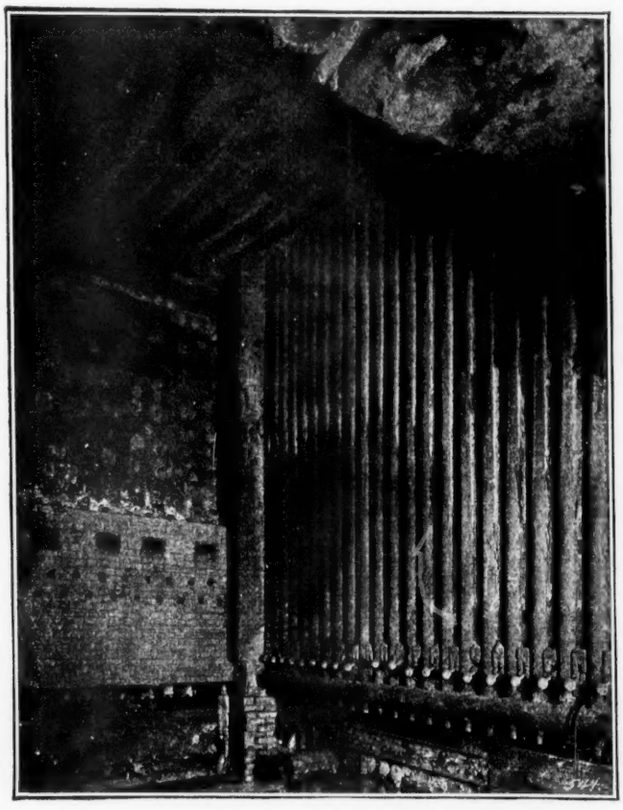


Fig. 2—Sherman Creek boiler No. 10

The water-cooled furnace was a success from the beginning. The circulation through the side walls was perfect; efficiencies of 84.6 per cent on the boiler, exclusive of economizer, were attained, and ratings up to 528 per cent were secured. In spite of the high ratings

*Released for simultaneous publication in *Combustion* and *Power*.

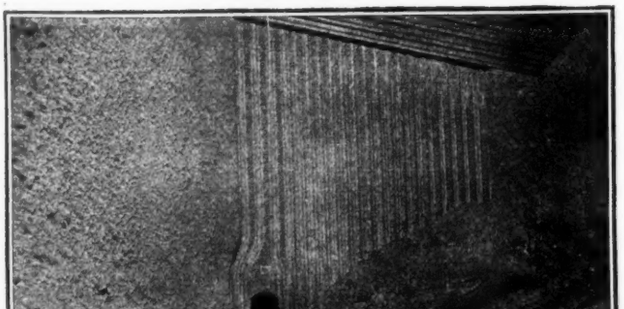


Fig. 3—Side wall of Hell Gate boiler No. 61

and high efficiencies the furnace showed no signs of hard usage, the brick was unimpaired, the side-wall tubes were without a flaw and there was no scale on the inside of the tubes.

Later, three more boilers were installed having 12,100 sq.ft. in the boiler proper, 460 sq.ft. of water-cooled side walls, and a furnace volume of 6,500 sq.ft. On a high capacity test one of these reached 730 per cent rating. These were followed by boilers Nos. 71, 72 and 73, each having 12,100 sq.ft. in the boiler bank, 450 sq.ft. in the side walls, and a furnace volume of 6,500 cu.ft.

First Application with Powdered Fuel

The water-cooled furnace was first applied to a powdered-fuel-fired boiler in the Sherman Creek Station of the same company. Six 6,710-sq.ft. Springfield boilers were so equipped, and a great variety of types of pulverizing, feeding and burning equipment were tried out. The boiler proper contained 6,280 sq.ft., the water-cooled side walls 430 sq.ft., and the furnace contained 3,060 cu.ft. This installation demonstrated beyond question the feasibility and success of the water-cooled furnace as applied to pulverized-fuel burning.

It was in one of these furnaces that the tangential method of burning pulverized fuel was first tried. Whether the swirl effect is secured is open to some question, but there is no doubt as to the effective combustion condition that is obtained.

The New York Edison Co. installed six Springfield horizontal boilers in the new East River Station. Each boiler proper contains 14,809 sq.ft. of heating surface and the water-cooled furnace contains 4,134 sq.ft. The volume of the furnace is 15,888 cu.ft. Each boiler has a capacity of 250,000 lb. of steam per hour, 375 lb. pressure at a total temperature of 700 deg. They are fired by means of the Lopulco standard down firing.

The New York Steam Corp. installed in the Kips Bay Station three 10,670-sq.ft. Ladd boilers the furnaces of which were provided with 4,132 sq.ft. of additional water-cooled surface. These boilers operate at a normal capacity of 325,000 lb. of steam per hour at a pressure of 275 lb. and no superheat. The furnace has a volume of 18,925 cu.ft. and is completely surrounded by the water-cooled surfaces. The coal is down-fired by means of the standard Lopulco System. These boilers are run normally at 700 per cent of rating based on the total surface of the boiler, water walls and bottom screen. That is approximately 22 lb. of steam per square foot of total surface. The surface exposed to the furnace in this case is about 35 per cent of the total surface.

A similar boiler and furnace, although of somewhat greater heating surface, is installed in the River Rouge Plant of the Ford Motor Co. at Detroit and has a capacity of 500,000 lb. of steam per hour.

The installations cited indicate clearly the tremendous effect upon boiler capacities of the water-cooled furnace idea and the savings in space and building cost that are thus made possible. Applied to boilers now in operation the water-cooled furnace will help to solve, in a great many instances, the problems of industrial plants that are faced with increasing demands for steam at low capital outlays.

Absorption of Radiant Heat

Because of the success of the water-cooled furnace a great deal of thought has been directed toward the phenomena that take place in such a furnace, to analyze the transference of heat to the surfaces into its radiant and convection components. The exposure of the additional heat-absorbing surfaces to the direct heat of the furnace has made it important to determine the amount of heat absorbed from the combustion gases before they pass out of the furnace and into the boiler proper. This heat is transferred by radiation.

It has been recognized for a long time that the transference of heat by radiation is at a high rate and is commonly assumed to be in proportion to the fourth power of the temperature differences between the body of higher temperature and the body of lower temperature. Broido, in his paper before the American Society of Mechanical Engineers, "Radiation in Boiler Furnaces," in December, 1925, presented a curve averaging the indicated results of radiation in several furnaces; this he called curve *G*, and it indicates the fraction of total heat liberated in a furnace that is absorbed in the fur-

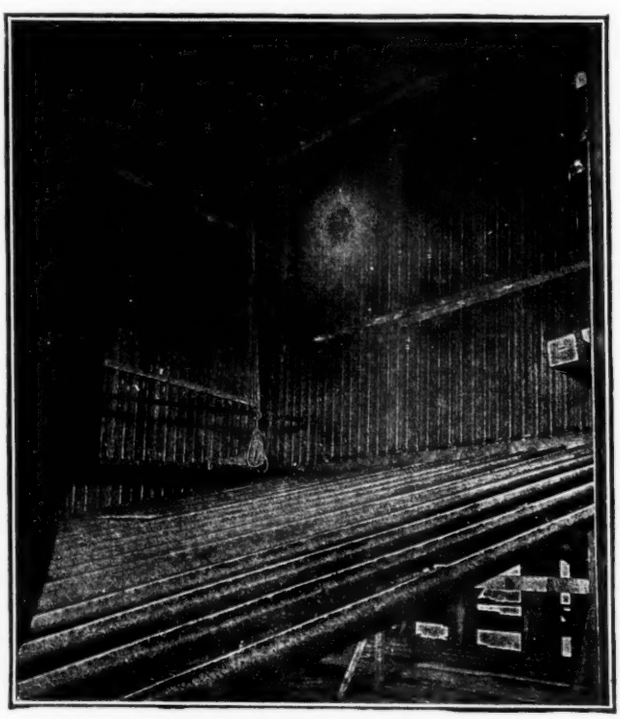


Fig. 4—East River boiler

nace. This curve is here reproduced. The ordinates show the ratio between the total heat liberated and the surface exposed to radiation, while the abscissas show the portion of heat absorbed in the furnace. The radiated heat absorbing surfaces are taken as the projected areas of the exposed surfaces.

The radiation of heat within the combustion gases, themselves, tends to an equalization of temperature within the furnace by the transmission of heat from localities of higher to those of lower temperatures, and a certain uniform temperature level would thus be established if uninfluenced by other factors such as convection currents and the stratification of the gases due to irregular draft conditions.

The temperature level attained in the furnace is dependent upon the heat value of the fuel, the CO_2 conditions and the rate of combustion, and is the resultant of the heat generated and the heat absorbed in the furnace.

Side-Wall Temperature Above Ignition Point

As mentioned previously, boilers provided with furnaces 100 per cent water cooled, are in successful operation, and it is evident that considerably greater radiant heat absorbing surface could be added without depressing the furnace temperature below the ignition point. The ignition temperature of carbon is between 800 and 900 deg. F., that of methane 1,240 deg., carbon monoxide 1,220 deg. and hydrogen 1,060 deg. As shown in the second curve, the temperature close to the side wall is still above the ignition point of the combustible gases and carbon particles.

Since the inclosing surface of a furnace increases less

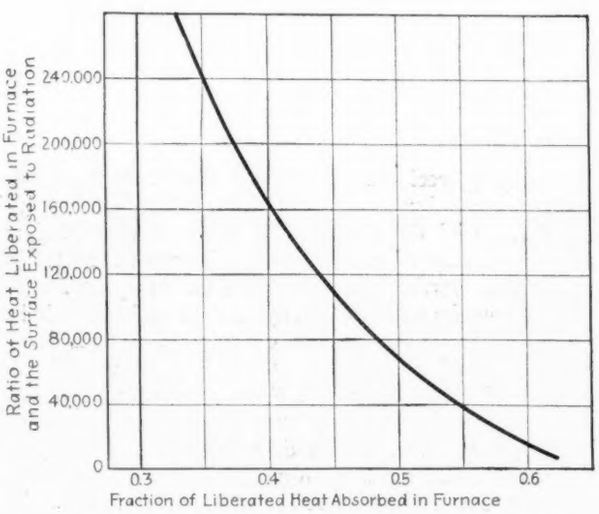


Fig. 5—Curve from Broido's paper on "Radiation in Boiler Furnaces"

rapidly than the volume, it is evident that the amount of water-cooled surfaces, in terms of percentage of the total absorbing surface that can be economically applied to a boiler, is greater as the size of the furnace is increased.

There was considerable reluctance at the time of making the installation at Sherman Creek to apply the water-cooled surfaces to the furnaces, due to fear that the temperature would be so appreciably lowered as to prevent proper combustion of the powdered coal. As a matter of fact the temperature in the water-cooled furnaces may be continuously maintained at a higher value than in a refractory furnace. Excess air may be decreased to a minimum value, indications are that CO_2 may be carried at about 18 per cent continuously, and a theoretical maximum temperature may be approached with a corresponding increase in furnace efficiencies. If this were attempted with a refractory furnace, the walls would be seriously affected.

With lower excess air furnace gases radiate more heat

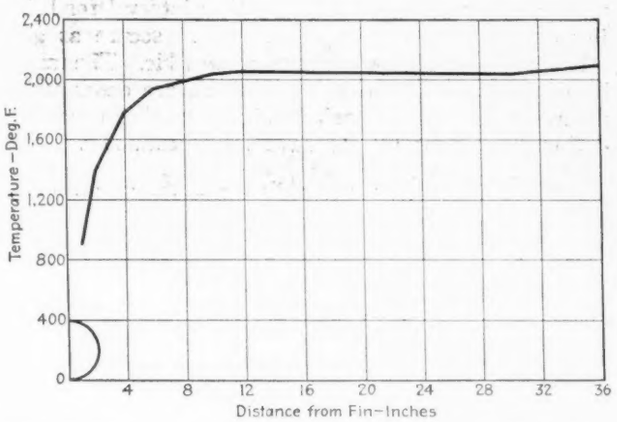


Fig. 6—The temperature close to the side wall is above the ignition point

not only because the temperature is higher, but because they are more transparent to the passage of the heat rays. It has been found by the physicists that oxygen and nitrogen are comparatively opaque to heat rays, while CO_2 and water vapor readily transmit them.

Heated air supplied to the furnace assists in propagating and maintaining ignition. It does not improve the mixing of the elements. If heated air enters the furnace at 450 deg. instead of 70 deg. F., each pound of air so admitted will absorb about 95 B.t.u. less heat from the fuel to raise it to combustion temperatures, and if 14 lb. of air is required to burn a pound of coal in the furnace, 1,330 B.t.u. will be saved by supplying the hot air, or roughly about 10 per cent of the heat value of the coal to the furnace. On the other hand, the total surface exposed to the furnace will absorb, as indicated by Broido's *G* curve, from 30 to 60 per cent of the heat liberated in the furnace, so that the supply of heated air furnishes only relatively a small amount of the heat absorbed by the exposed surface. Its chief value lies in the assistance it renders to the rapidity and stability of ignition.

On some tests that were run in 1911, combustion rates of 250,000 B.t.u. per cu.ft. were obtained on stoker-fired boilers. There was no doubt as to the burning of the coal even though the stoker and boiler did not operate as efficiently as at lower rates. There is, therefore, nothing in the process of combustion, itself, that would prevent the burning of coal in the pulverized form in at least as confined space as this rate indicates provided the elements can be brought together.

The velocity of the gases through the furnace mentioned was of the order of 1,900 ft. per min., which is not excessive considering the furnace merely as a duct, or passage for the gases. Higher combustion rates infer the taking of the gas away more quickly or, what amounts to the same effect, the reducing of the volume of the gases more rapidly. The water walls accomplish to a

considerable extent the latter effect by the rapid absorbing of the heat of the adjacent gas and correspondingly reducing its volume.

In the stoker fired boiler referred to, the coal was fixed in position and air was vigorously forced across it. High combustion rates were readily attained. With powdered fuel, on the other hand, the coal itself, as well as the air, is in motion and it is more difficult to secure a high relative velocity between them. The result has been to design the furnace and the method of introducing the coal so as to permit a longer time interval for bringing the coal and air together, and to secure as great relative motion between the two as possible. The mixing burners and tangential firing methods are endeavors to secure high relative velocity within a smaller time limit.

Some excellent results have been attained with the tangential method.

The combustion of fuel in the furnace is due to the uniting of the oxygen in the air supplied, with the carbon, hydrogen and sulphur of the fuel. It is facilitated by bringing the elements intimately together and the more rapidly this can be accomplished the higher will be the combustion rates. The natural affinities of the elements for each other are so intense that the effect of the containing surfaces is negligible. The chief problem in combustion is the bringing about of this intimate mixing. With proper mixing stability of ignition is assured and complete combustion is the result irrespective of the construction of the walls of the furnace. Unstable ignition is experienced only when the proper mixing of combustible quantities of fuel and air is lacking.

In mixing burners the purpose is to secure a short flame. The idea is to mix the coal and air thoroughly in the burners before they enter the furnace and thus increase the speed of ignition or flame propagation, so as to complete the combustion as near as possible to the mouth of the burner.

So far as the water-cooling of the furnace is concerned, the method of introducing the coal and air is more or less immaterial. With tangential firing, however, the abrasive action of the coal against the side of the furnace is more severe than with most mixing burners, and renders refractories useless for tangential firing; the steel surfaces of the bare tube water walls, on the other hand, are not affected by this action. In the design of the water-cooled furnace consideration must be given to two factors, circulation and expansion.

In the original water-cooled furnace at Hell Gate water is brought to the lower header of the wall tubes by a pipe entirely outside the furnace, which insures a solid column of water of considerable height to overbalance the lighter mixture of water and steam in the wall tubes exposed to the furnace heat and maintains a vigorous flow through them. The path of the water through the wall headers and tubes is so arranged that the friction head is substantially the same whether the water passes through the first wall tube or the last. This gives an equal distribution of water to all tubes.

In order to provide for the movement of the wall tubes and boiler due to temperature changes, the water walls are arranged so as to be free to move independently of the boiler proper.

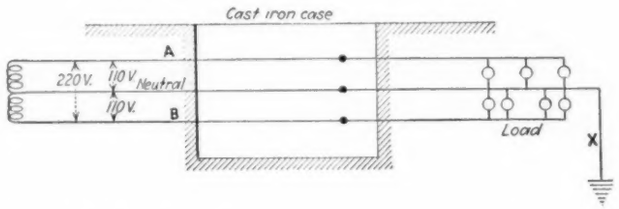
Careful attention given to these two factors in the design of the original water-cooled furnace undoubtedly accounts for the success with which it operated from the beginning, and it is essential to provide properly for the same two factors in designing any water-cooled furnace.

How Electrical Ground Shocks Were Caused

By George I. Mackenzie

The possibility of receiving electrical shocks from the ground is a contingency that seldom arises, but when such a condition does exist the results are sometimes more disastrous than might at first be surmised. Some of the effects of ground shocks are harmed or frightened children, runaway horses with their menace to traffic, and a general fear by all living things unfortunate enough to tread the electrified spot.

During the last year it was my experience to investigate the cause of an interesting condition of this nature. In a suburban district the electrical distribution system



Distribution box that became electrified, causing shocks

was all underground and the service wires that supplied the various consumers were tapped from the underground secondary at cast-iron distribution boxes, the covers of which were on a level with the surface of the street. The outside surface of each box was in direct contact with the earth, but the electrical connection between the earth and the box was of high resistance. The figure shows a schematic diagram of the circuit under normal operating conditions. The two outside wires *A* and *B* are the live legs of the circuit, and the middle or neutral wire is grounded to the water pipe on the consumer's premises. This ground wire *X* under ordinary conditions is simply a safety precaution and does not carry any appreciable amount of current.

Upon investigation it was found that the earth in the vicinity of the distribution box was electrified and test results showed a 50-volt drop between the cast-iron box and the earth. The street was then dug up and one live leg was found to be partly broken and grounded on the box. It was therefore charged to a considerable potential relative to earth, and a current was flowing from the box to the earth. The greatest voltage drop was the earth immediately surrounding the box; therefore if a person or animal walking on the street happened to have one foot on the cover of the box and the other on the ground, an electrical shock would result. The maximum possible voltage drop under these conditions is only 110 volts, but less than this is quite sufficient to alarm pedestrians or animals unexpectedly coming in contact with it.

If the live wire had been totally grounded, the primary fuses on the transformer would have blown and opened the circuit, thereby preventing the hazards that actually existed. When the cable failure was repaired, operating conditions became normal, and several low-voltage complaints which had been reported were cleared up. There is a general belief that when an object is in contact with the earth an electric shock cannot be obtained from it, but the foregoing is a good example how such shocks may occur.

Money Is Not Required To Improve an Ice Plant

By C. T. Balser*

HUNDREDS of ice plants are operated in a wasteful manner simply because the management and the engineer feel that efficiency is obtainable only at a heavy expenditure. In many of these the needed improvements call for no great capital outlay and no superengineering talent to outline and execute. It often happens that the simple things, the things that are plainly obvious, are the ones that, if remedied, spell the difference between loss and profit.

A DISTILLED-WATER ice plant that was so situated as to prevent its being changed to raw-water ice, was having trouble due to high operating costs and reduced capacity. The owner decided on making such changes as were necessary to improve conditions, and an investigation was undertaken to see what changes were needed.

The plant was a small one, rated at 20-tons daily capacity, and consisted of one Corliss-driven vertical ammonia compressor carrying a load of two freezing tanks and an ice storage room 40x40x26 ft., cooled by direct-expansion coils. Steam for the engine and the several steam pumps was supplied by a horizontal fire-tube boiler at 125 lb. pressure.

The time selected to make the change was in the fall and winter months, when the plant could be shut down for some time, consequently it was possible to do a thorough job of dismantling and investigation.

The Coils Needed Cleaning

The two freezing tanks were emptied of brine and thoroughly cleaned of dirt and débris of several years' accumulation, after which the coils were examined to determine their condition. It was discovered that no provision had been made at the time of installation to drain oil or other foreign matter from the coils of either tank and that in each tank some of the coils were arranged six pipes high and some eight. This is not considered good practice since it allows short-circuiting of ammonia through the coils containing the lesser amount of pipe and, on the whole, creates an unbalanced condition difficult to control.

Sufficient pipe was ordered to build up all coils to an equal height of eight pipes and permanent oil drains were provided, two at the bottom header in each tank, with the drain pipes carried through a stuffing box in the ends of the tanks and drain valves conveniently located so as to permit draining at any time while the plant was in service.

After the coils were built up to the proper height, they were tested for leaks with air pressure and thoroughly blown out, the blowing operation removing nearly one-half barrel of oil from the coils and connections.

The coils, as originally installed, afforded only 217 ft. of pipe per ton, based on 20 tons capacity, which is a meager allowance for the particular type of coil arrangement used, but when the additional pipe was installed, the coil ratio per ton capacity was considerably bettered, being 265 ft., or an increase of 48 ft.

A Defective Fore-Cooler

An examination was next made of the distilled water fore-cooling tank, which disclosed the fact that the distilled water from the fore-cooling coils was not circulating in such a manner as to make all coil surface effective; this condition was remedied by installing baffles to direct the flow of water to cause all coil surface to do useful work. To improve these coils further, a ⅜-in. expansion valve was connected to the return-gas inlet of the tank in order to increase the cooling effect above that possible with only the suction gas from the freezing tank.

The atmospheric steam condensers were of the double-pipe type, 8 pipes high by 16 ft. long, made from 1¼- and 2-in. pipe. As there were only eight stands installed, two additional stands were provided in order to increase the steam condensing capacity and prevent the loss of exhaust at the relief valve, also to reduce the back pressure on the exhaust piping system. The ammonia condensers, as originally installed, consisted of six double-pipe stands 8 pipes high by 18 ft. long, made from 1¼-in. and 2-in. pipe.

Later, these condensers had been converted to the flooded type, but as such were not satisfactory; accordingly, they were reconverted to the standard double-pipe counter-current type, removed from a high platform and placed on concrete piers near the ground, where they were more accessible for cleaning.

Spray Pond Was Too Small

Condensing water for both the steam and ammonia condensers was handled by one pump, then delivered to a small spray pond for cooling. The final temperature of this water in the summer months as it left the spray pond was too high for economical ammonia condenser operation, and in order to improve matters, a small cooling tower was erected to handle the water from the steam condensers, while the spray pond was used for the ammonia condensers. By thus dividing the work between two separate systems of cooling, it was possible to reduce the final water temperatures for both the steam and ammonia condensers several degrees. The original spray system was not large enough to handle the total condensing water requirements properly; then again, it

*Consulting engineer, Atlanta, Ga.

is seldom, if ever, good practice to attempt the cooling of water for use in both atmospheric steam condensers and ammonia condensers with the same system, whether the cooling is done by cooling tower or spray pond. Invariably, the final temperatures realized are not low enough for best results so far as the ammonia condensers are concerned.

An uneconomical slide-valve engine of doubtful vintage was used to operate the condensing-water circulating pumps, brine propellers, etc., and since this unit was so wasteful of steam and lubricating oil, it was decided to operate the lineshafting to which this engine was belted from a small belt wheel on the end of the crankshaft of the ammonia compressor. This proved entirely practical and permitted the stopping of one of the largest fuel losses in the plant.

Overhauling the Steam End

Finally, all compressor valves were ground in to a good seat, new rings placed on the ammonia pistons and the setting of the steam valves checked. All steam leaks received attention and both the engine and tank rooms were thoroughly cleaned, the walls being whitewashed to improve the general appearance.

The boiler plant was then carefully gone over, which disclosed a rather bad condition of the boiler brickwork, permitting the loss of fuel due to the entrance of cold air at several places. The setting was repaired and the boiler was given a thorough cleaning, provision being made for the regular blowing of the tubes with steam.

The plant was placed in service early in the spring and operated until the close of the season late in November without trouble of any kind, at the same time producing 23 tons of ice, besides refrigerating the ice storage, at a decided saving in fuel. Condensing pressures of 225 to 230 lb. were common in previous years, while the highest pressure reached after the changes were made did not exceed 185 pounds.

The saving in fuel and the increase in capacity resulting from the changes as described, more than justified the expense involved and resulted in a decided increase in net profits at the end of the year.

It Is Possible To Have the Suction line between the evaporator and the ammonia compressor so well insulated and the ammonia so handled that a thermometer inserted in the suction line close to the compressor will show a temperature corresponding to the saturation point for the pressure carried; as example, 0.1 deg. when the back pressure is 30 lb. absolute. However well insulated and water-jacketed the compressor may be, the temperature of the ammonia will increase in its passage into cylinder, for the suction valve, piston, cylinder head and cylinder walls have a temperature much higher than the incoming ammonia. The ammonia at the end of the suction stroke will not be a saturated vapor, but a superheated gas. Just what the degree of superheat will be will depend on the condition of the compressor. In a single-acting dry machine this temperature is in the neighborhood of 100 deg., at which each pound of the 30-lb. superheated gas occupies 11.55 cu.ft. If the superheat should be 150 deg., and it often is, the volume will be 12.65 cu.ft. to the pound. As it is impossible to prevent superheating in the cylinder, the superheat should be kept as low as possible. Have the ammonia reach the compressor in the greatest degree of saturation permissible with the type of machine and the operating conditions.

Some Experiences in the Use of Stainless Steel

By Robert Karp*

Although various countries claim the honor of the discovery, the real inventor of stainless steel is, according to common opinion, the well known Brearly, of the Brown, Bayley Steel Works, of England. Germany, however, was working simultaneously on the same matter, and the Soderfors Steel Works, of Sweden, first manufactured, during the early part of the World War, a chromic steel for tools which was the same thing as is now known as stainless steel. As a result of these various activities there are no difficulties in Sweden, as far as patents are concerned, in the manufacture of the steel itself, the patents pertaining to the articles made from the stainless steel.

Various uses have been made of stainless steel at the STAL Works. Small axial turbines and feed-water pumps are constructed entirely of stainless, and on special order the double-rotation turbines are equipped with stainless blades in the saturated part, with stainless-steel shaft packing and with some stainless drain pipes and valves. Generally, the experience with stainless has been quite satisfactory in small turbines. Where big pieces, however, either cast or forged, have been tried, it has been found that there is a tendency for the metal to warp at high temperatures, causing the pieces to become deformed, even though heat-treated. An investigation of the trouble is being made by Swedish manufacturers.

The use of stainless steel for boiler tubes has also been tried. A separately fired steam superheater equipped with tubes of stainless has been running for six months at a pressure of 294 lb. and a temperature of 932 deg. F. with no trouble. One of the railroads in the south of Sweden has to use very bad feed water and consequently had considerable trouble with their boiler tubes. In 1925 a locomotive was provided with stainless tubes, and after a service of one year two tubes removed for inspection showed no evidence of corrosion. The locomotive is still running without having had any tube trouble, and as a result of this experience the railroad company plans to extend the use of stainless tubes.

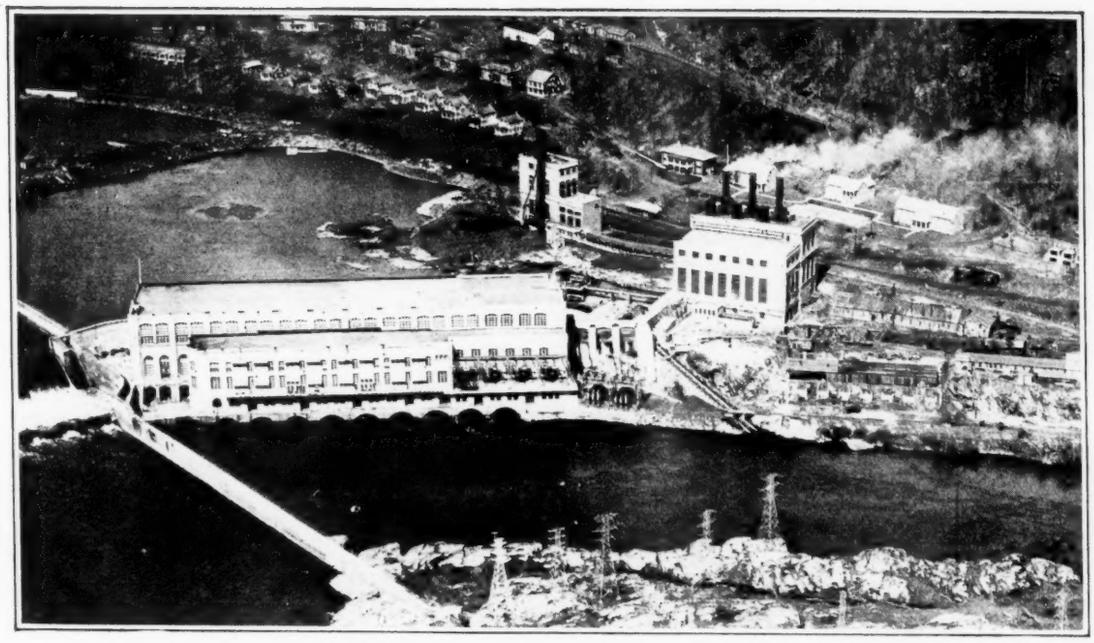
The great advantage of stainless tubes is that the scaling (oxidation) temperature is considerably higher than for common tubes. This is especially important in boiler tubes where the temperatures are high and the circulation sometimes unsatisfactory.

The mechanical properties of stainless when cold can be varied from extremely soft to the hardest material, depending upon the analysis and the heat treatment. In this connection it should be remembered that the resistance against erosion depends not only on the hardness, but on the composition. In addition, if the material is to work at high temperature, it should have a curve of stress without any deflection as for common steel.

COMPARATIVE PRICES OF METALS IN SWEDEN
(ON THE BASIS OF 1)

Carbon steel, C = 0.40	1.0
2 per cent nickel steel	1.5
3 per cent nickel steel	2.0
5 per cent nickel steel (for blades)	3.3
Stainless steel	6.0
Monel metal	18.0
Common cast iron	1.0
Common cast steel	2.0
Stainless cast steel	7.0
Mild-steel boiler tubes	3.0
Stainless-steel boiler tubes	7.0

*Svenska Tubinfabriks Aktiebolaget Ljungstrom, Finspong, Sweden.



Holtwood hydro-electric plant on the left, steam plant on the right

Operation of Hydro and Steam Plants in Parallel*

By F. A. ALLNER

General Superintendent, Pennsylvania Water and Power Company, Baltimore, Md.

HOLTWOOD steam plant is situated on the Susquehanna River, about 24 miles above tidewater, adjacent to the 111,000-kw. hydro-electric plant of the Pennsylvania Water & Power Company, and is part of a hydro-steam system, with a total installed generator capacity of about 370,000 kw. This steam plant burns pulverized coal, contains three 14,000-sq.ft. boilers and two 10,000-kw. generators. The plant is laid out for an ultimate capacity of at least 120,000 kw. and went into operation in July, 1925.

Formerly called the McCalls Ferry, the Holtwood hydro-electric development is a low-head run-of-river plant with an average head under present conditions of about 52 ft. In Oct., 1910, the first unit went into operation, and since the initial five-unit installation the plant has been extended in several successive steps, reaching its present rated capacity of 111,000 kw. early in 1924. The rated capacity of the waterwheels varies from 13,500 hp. for the older double-runner type to 20,000 hp. for the latest single-runner type.

Normal full-load discharge of the hydro-electric plant is now about 30,000 cu.ft. per sec., with a maximum under favorable hydraulic conditions of 31,500. The former flow is available in the average year 41 per cent of the time. The flow of the Susquehanna is unusually variable. Since the plant went into operation in 1910, the lowest 24-hour flow recorded at Holtwood was 3,200 cu.ft. per sec., and the lowest seven-day average was 3,600 cu.ft. per sec.; the maximum 24-hour flow was 441,000 cu.ft. per second.

A reservoir formed by the Holtwood dam has an area of about four square miles and a draw-down capacity of approximately

STEAM plant having two 10,000-kw. units is located at the hydro station and is designed for operating conditions at the hydro plant. The hydro units, which are rated at from 13,500 to 20,000 hp., are commonly brought up to speed from standstill and synchronized with the system in less than a minute without any preliminary preparations, and frequently the time is less than one-half minute. When designing the steam-turbine equipment, particular attention was given to ability to start quickly and under normal conditions one of these machines can be put on the system in 25 minutes, and in an emergency the time can be reduced to 15 minutes.

*Abstract from a paper presented at the Summer Convention of the A.I.E.E., Detroit, Mich., June 20-24, 1927.

800,000,000 cu.ft. Under present conditions of system-load demands this draw-down gives complete weekly pondage to equalize effectually differences in daily flow and shape of load curve up to an average weekly river stage of 4,200 cu.ft. per sec. The term "complete pondage" means that if the hydro-electric plant carries the entire system load above a certain base steam line, and the forebay on Friday evening is brought to a point not below the desired minimum level, the pond will fill again by Monday morning without spilling. In other words, the inflow of the river between Friday evening

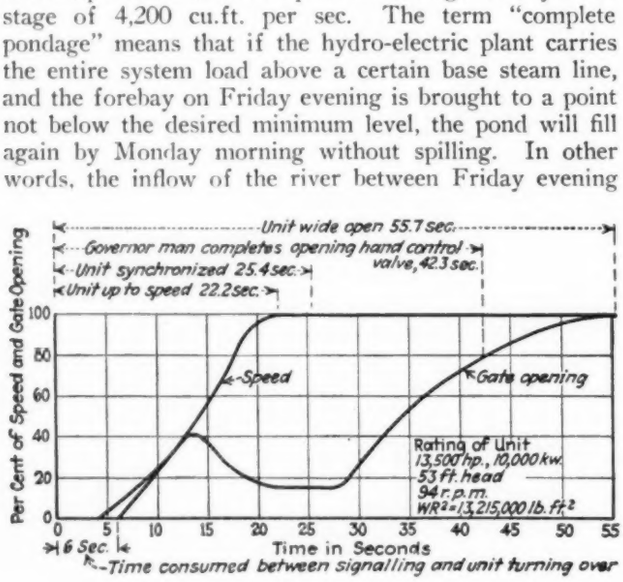

Unit wide open 55.7 sec.
Governor man completes opening hand control valve, 42.3 sec.
Unit synchronized 25.4 sec.
Unit up to speed 22.2 sec.
Per Cent of Speed and Gate Opening
Speed
Gate opening
Rating of Unit
13,500 hp., 10,000 kw.
53 ft. head
94 r.p.m.
WR² = 13,215,000 lb. ft.²
6 Sec.
Time in Seconds
Time consumed between signalling and unit turning over

Fig. 1—Analysis of the time required to start a 10,000-kw. hydro unit

and Monday morning, minus whatever is used for a small amount of generation during that period, will be discharged during the period from Monday morning to Friday evening, in addition to the inflow of the river on these five days.

Generally speaking, during high or excess flow the aim is to deliver the maximum amount of energy from the river. As long as there is water wasted over the dam, hydraulic efficiency is of no importance. As long as possible, the hydro-electric units are operated at full load and carry as much of the system load as is practicable when this is less than the hydro-electric capacity. Under these conditions the steam plants operate on the peaks and carry all swings. In low or deficient flow the steam plants are given the base load and the hydro-electric plant operates on the peaks and takes care of load fluctuations. This is done, even though such operation under average low-flow conditions causes an energy loss of about 7 per cent, and at very low river stages as much as 15 per cent, compared with 100 per cent load factor, base-load generation. These differences are due more to the large hydraulic gradient of the tailrace than to the carrying of swings and the uneconomical loading of individual units.

Under normal conditions the pond is drawn upon only to the extent of compensating for daily and week-end fluctuations in inflow and load demand. Restoration of maximum pond level is aimed for on the morning of every weekday. Thus the maximum practical amount of pondage is held in reserve to meet major emergency conditions or temporary outages at the steam plants.

The Holtwood steam plant was designed not so much for maximum economy or minimum first cost, but primarily for mechanical sturdiness, reliability of service, quick starting, ability to float in at no-load and for facilitating the proper division of load between hydro-electric and steam plants.

Electrically speaking, the steam plant is essentially a part of the 60-cycle section of the hydro-electric plant. The steam-plant generator leads are carried through a cable duct to oil switches located in the hydro-electric plant switchroom. The control panels for the steam units are a part of the 60-cycle switchboard in the hydro-electric plant.

Size and Type of Generating Units

From the point of view of low first cost and of economy of operation under base load conditions, larger generating units would have been desirable. However, these considerations were subordinated to sturdiness, reliability of service, quick starting and maximum coordination with the hydro-electric plant. Furthermore, under the existing conditions these initial steam units must often operate at a comparatively small load, either when separated from the rest of the genertaing system, or in high flow when operating on the peaks so as to

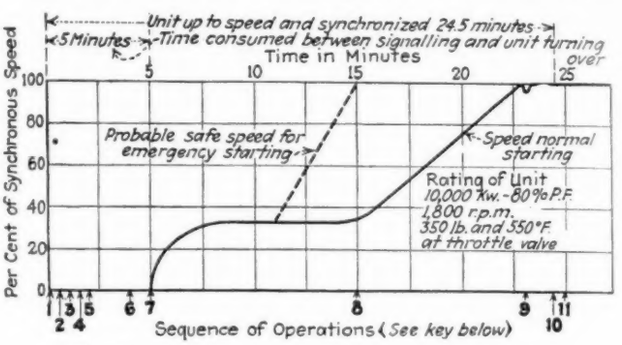

Unit up to speed and synchronized 24.5 minutes
5 Minutes
Time consumed between signalling and unit turning over
Time in Minutes
Per Cent of Synchronous Speed
Probable safe speed for emergency starting
Speed normal starting
Rating of Unit
10,000 kw.-80% P.F.
1,800 r.p.m.
350 lb. and 350° F. at throttle valve
Sequence of Operations (See key below)

Fig. 2—Analysis of the time required to start a 10,000-kw. steam unit

No.	Operations by Engineer	Condenserman	Oiler	Swbd. Operator
1	Signals to condenser room to start condensate and circulating water pumps			Signals to engineer
2	Closes turbine drains and turns water and steam on shaft seals	Starts condensate pump	Opens valve to auxiliary steam line	
3	Starts steam jet air pump	Circulates condensate to tanks		
4	Starts auxiliary oil pump	Starts circulating pump		
5	Turns steam into turbine main			
6	Vents condenser water box and siphons water into tail pipe			
7	Opens throttle valve and brings turbine to ½ speed			
8	Brings turbine to speed and puts water on shaft seal, signals switchboard to close generator field circuit breaker			
9	Trips turbine by oil trip and reopens throttle valve			
10				Synchronizes generator
11	Adjusts seal leakoff, turns water on air and oil coolers	Turns condensate into suction header of boiler feed pump		

take the top of the load and give the hydro-electric units maximum load. All these considerations pointed toward relatively small sturdy machines for the initial installation, approximating in capacity the hydro-electric units.

On a hydro-electric system in high flow, when the system load is less than the hydro-electric capacity, the steam plant should be shut down at night. It should theoretically, not operate in the morning until the load becomes equal to the hydro-electric capacity, when it picks up that portion of the load over and above the hydro-electric capacity. Modern steam turbines designed with small clearances and operating at high temperatures

require, normally, approximately one hour for starting. This, of course, entails the use of steam before it is really required. If it is desired always to have spare steam capacity available for immediate use in the event of breakdowns, it is necessary to operate normally a larger number of units than would be required for most economical generation.

Hydraulic turbines operating at low or medium heads or having only short penstocks, are inherently quick-starting machines. Temperature differences are practically nil, clearances are relatively large, and construc-

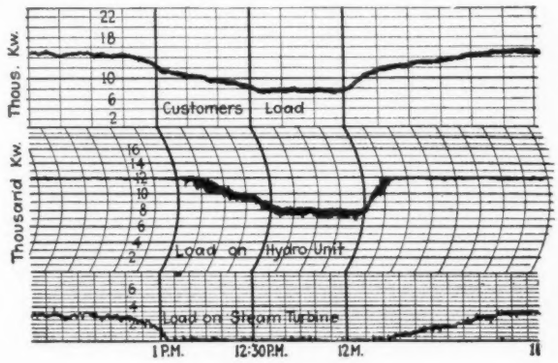


Fig. 3—Wattmeter charts during floating-in period over the noon hour

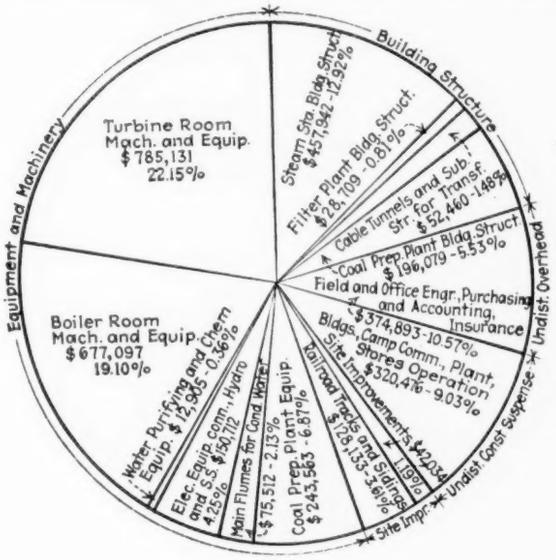
tion is sturdy. The starting time can be further reduced by special arrangement of control valves and instruments, by automatic starting of pumps supplying the pressure fluid of servo-motors, etc., and by training the operators. At the Holtwood hydro-electric plant any of the 10 units, ranging in capacity from 13,500 to 20,000 hp., is commonly started from standstill, without preliminary preparation, and synchronized in less than one minute, and frequently in less than half a minute. Fig. 1 gives an analysis of the few steps involved in this operation, requiring only two men—the governor man and the switchboard operator.

Low-flow stand-by service of a low-head hydro-electric plant equipped with pondage has well been called "alternating-current storage-battery service." In other words, it has the ability to synchronize its entire capacity in a few minutes and maintain full output for several hours or days, and thus tide over temporary emergencies at the steam plants. During the high-flow period this emergency service is not available at the hydro-electric plant, because of all hydro-electric units are operating at maximum gate opening.

When considering steam generation at Holtwood, the power company desired to extend so far as practicable this quick starting ability to its steam plant, thus giving to the hydro-electric steam combination a certain amount of quick emergency service also during the high-flow period. This was one of the reasons for selecting a particularly sturdy type of turbine of relatively small size. The specifications provide that "every effort is to be made in the construction of these machines to make them suitable for starting up in the minimum time." Under normal conditions a Holtwood steam unit is paralleled in twenty-five minutes, and in emergency the time can be reduced to fifteen minutes from the time the start signal is given. Fig. 2 gives an analysis of the operation. A total of four men are engaged in this operation, and the time consumed and the number of steps are in striking contrast to hydro-electric starting.

The desire to facilitate quick starting was the chief reason for limiting the superheat in the initial installation to a total temperature of 550 deg. F. at the throttle. In future extensions it is planned to install larger units, using the first two for quick-starting purposes. At that time radiant-type superheaters may be installed, giving a total steam temperature of 725 deg. Various schemes have been proposed for maintaining the quick starting feature on the first units, if and when this step is taken, such as omitting the radiant superheater in one boiler, use of a Ruth's accumulator, etc.

As a practical matter, in a case such as the previously mentioned building up of load, and whenever the load is at or near the hydro-electric capacity, it is necessary to have spare capacity on the bus. At such times in high flow any load carried by a steam unit causes a net loss of the equivalent amount of water power. It is therefore highly desirable to have steam units able to float in or motor at no load. On the Holtwood units a bypass is provided around the main steam control valves to admit enough steam to the turbine to keep it cool. The manufacturers' guarantee provides that with this bypass connection open "it will be possible to motor the turbine


Building Structure
Equipment and Machinery
Undist. Overhead
Undist. Const. Suspense
Site Impr.
Turbine Room Mach. and Equip. $785,131 22.15%
Steam Sta. Bldg. Struct. $457,942 - 12.92%
Filter Plant Bldg. Struct. $28,709 - 0.81%
Cable Tunnels and Sub. Str. for Transf. $52,460 - 1.48%
Coal Prep. Plant Bldg. Struct. $196,079 - 5.53%
Field and Office Engr., Purchasing and Accounting, Insurance $374,893 - 10.57%
Bldgs., Camp Comm., Plant, Stores Operation $320,476 - 9.03%
Site Improvements $42,034 - 1.19%
Railroad Tracks and Sidings $128,133 - 3.61%
Coal Prep. Plant Equip. $243,583 - 6.87%
Main Flumes for Cond. Water $75,512 - 2.13%
Elec. Equip. comm., Hydro and S.S. $150,712 4.25%
Water Purifying and Chem. Equip. $12,905 - 0.36%
Boiler Room Mach. and Equip. $677,097 19.10%

SUMMARY

Bldg. Struct.	$ 735,190	20.74%
Equip. and Mach.	1,944,920	54.86%
Undist. Overhead	374,893	10.57%
Site Improvements	170,167	4.80%
Undist. Const. Susp.	320,476	9.03%
Total	$3,545,646	100.00%

Fig. 4—Analysis of construction costs

by means of its generator with the control valves shut off a period of one hour without overheating any parts of the turbine."

A ¾-in. orifice is at present installed in the bypass. It has been found that this discharges enough steam to drive the unit at slightly more than synchronous speed under excitation. This is more than is necessary for cooling and prevents lowering of the speed for synchronizing unless the speed is reduced by manual manipulation of the vacuum or the throttle. Tests are not yet completed to determine the safe minimum size of orifice.

Fig. 3 illustrates the division of load between a 12,000-kw. hydro-electric unit and one of the steam units over the noon-hour drop when operating in parallel on the Lancaster 60-cycle load separated from the rest of the system. Until about 11:55 a.m. the gates of the hydro-

electric unit are wide open, with the steam turbine taking the momentary swings and the more gradual load changes. When the customer's load drops below the hydro-electric capacity, the hydro-electric governor begins to function or to maintain the frequency as the operators say, and the steam unit floats in or motors. Occasionally, small amounts of power are momentarily supplied by the steam turbine, due to slight decreases in frequency which draw on the kinetic energy stored in the rotor and also in a few cases probably cause the steam governor to open a control valve momentarily. The graphic chart of steam-turbine output does not show input when momentarily motoring, because of a zero stop on the meter. When the load has increased to the capacity of the hydro-electric unit, the conditions prevailing before the noon hour are restored. A short time before noon the rate of coal feed to the boilers is reduced so as to lower the steam pressure sufficiently to avoid blowing-off as the load drops. The burner flames are extinguished just before the beginning of the motoring period, but are relighted occasionally as required to maintain the pressure within the desired range.

In order to change the per cent speed regulation on the standard-type governor, it is usually necessary to shut down the steam turbine. In a hydro-electric steam system such as has been described, when the steam unit is carrying the base load it is desirable that its regulation should be relatively large, whereas when it is carrying the load fluctuations or peaks and the hydro-electric units are carrying the base load, the steam-unit regulation should be relatively small. The Holtwood steam units operate also in parallel with a number of other steam units, where regulation cannot be adjusted while running.

Control of Steam-Turbine Regulation

In order to control Holtwood steam generation with respect to the other steam stations, either toward assigning to the Holtwood units a steady load or a fluctuating load, it was thought desirable to be able to change from one condition to the other without shutting down the unit. Hence a special motor-driven device was installed for changing the governor regulation. This device is controlled from the switchboard in the hydro-electric plant. The specifications provide for an adjustment range from 1 per cent to 5 per cent, although the guaranteed range is only 2 per cent to 5 per cent. Tests made on the governors at the factory showed a range from 1.6 per cent to 7.4 per cent.

The manufacturer's guarantees provide that the characteristics of the governors are such that there will not be any hunting between the steam turbines and the hydro units or between the two steam turbines under either of the following operation conditions:

1. Steady continuous load carried on waterwheel generators and fluctuating load carried on the steam turbines.
2. Steady continuous load carried on steam turbines and fluctuating load carried on waterwheel generators.

The guarantees also provide that the speed regulation and the speed of operation of the governor and control mechanism of the turbine will be such that with full load thrown off the generator and the field circuit breaker opened simultaneously, the speed will not exceed that for which the emergency trip is set; the latter is to be not over 110 per cent.

In order to make it possible to restore normal frequency in case of a sudden overload due to the breakdown of a generating unit or to other cause, by paralleling a steam unit without cutting off customers' load, a particularly wide range is provided in the governor control of the Holtwood units. The speed can be changed by remote control from 107 per cent or 64 cycles to 85 per cent or 51 cycles, but in the latter case the bypass around the control valves must be throttled which, as stated previously, is at present too large.

The heaviest duty on the steam units occurs in the period of very low flow, which usually is also a warm-weather period. Also in cold weather, as for example, in case of a frazil-ice run, it may be desired to throw the maximum possible overload on a steam unit for a short time. This was the cause of conservatism in condenser design. For ordinary conditions probably a 9,000-sq.ft. single-pass condenser would have sufficed, but in line with the policy of insuring a safe margin of capacity and maximum co-ordination with the hydro-electric plant, even at the expense of first cost, a 13,000-sq.ft. single-pass condenser was installed on each unit. Sustained gross generating capacity for highest water temperature in December (38 deg. F.) was found to be 15,200 kw. limited by the turbine, and for highest water temperatures in September (75 deg. F.), 13,200 kw. at 100 per cent power factor, limited by the heating of the generator field coils.

Construction and Cost Data

Decision to build the steam plant was made April 2, 1924. The turbine-generators were ordered May 23, and excavation began June 24 of the same year. The first generating unit went into regular commercial operation July 20, 1925, and the second on August 4 of that year. The design work was carried out by the Consolidated Gas, Electric Light & Power Co. of Baltimore. The field engineering and construction work was handled by the power company's own forces.

Fig. 4 is a summary of the cost of the plant, exclusive of property, legal and corporate expenses, housing for employees, interest during construction and exclusive of any contractors' fees. Several factors should be borne in mind in comparing these costs with those of other plants. The present boiler installation is larger than needed for the first two turbines, and surplus pulverizing capacity on a bituminous rating was installed to offset partly the reduction in capacity when milling river coal. Switching equipment is installed for two more units, and the cable tunnel to the hydro-electric plant will take care of the ultimate station. The intake and discharge tunnels are built for two more units having a capacity up to 35,000 kw. each. The width of the power house is sufficient to accommodate units up to 35,000-kw. capacity and larger boilers.

It may be of interest to note that the cost of the preparation plant per net ton of pulverized output per hour on a bituminous rating was $8,720 for structures and $10,830 for equipment, or a total of $19,550.

Conclusion

The relatively wide range of operating conditions at the Holtwood steam plant in respect to character of fuel, amount of generation, shape of load curve, co-ordination with hydro-electric plant, etc., involved a number of interesting problems in design and operation for which only a limited amount of experience was available from other installations. It is felt that nearly all these major problems have been solved satisfactorily, but there is still need for further experimentation to secure the best possible results from the equipment now installed.

What Capital Expenditure Is Justified by Thermal Savings?

THE installation of new and improved equipment is justified by the net saving in dollars and not the saving in B.t.u.—Determinations of the economic limit of first cost are simplified by the accompanying chart

THE modern development of power stations is marked by many thermal improvements, such as increased boiler pressures, higher steam temperatures, reheating and regenerative cycle, pulverized fuel and air preheating, all of which effect a reduced consumption of coal per kilowatt-hour generated, amounting in some cases to a saving of 10 to 20 per cent.

When regarding such enormous savings one may be led to believe that all these improvements, should be immediately put into practice. Nevertheless, we find in many cases that power stations newly planned are built as before, with many of the modern improvements apparently not considered. At first thought it would appear that the engineers designing such a plant are behind the

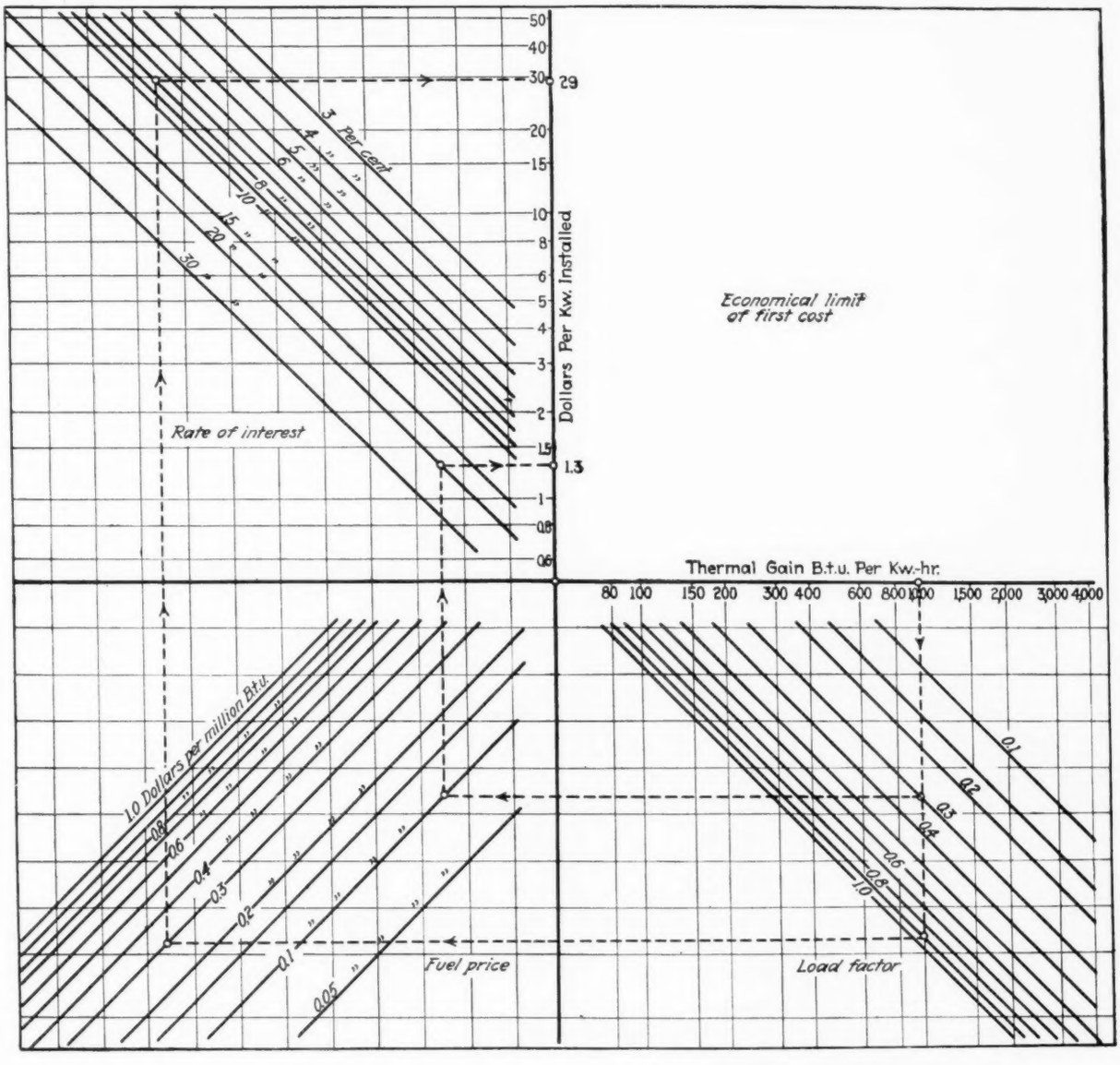


Chart for determining the economical capital expenditure justified by a given thermal saving

times and not up to their job, but study will reveal the reason for their choice of equipment.

First there is the question of safety and continuity of of service, which is more important than thermal efficiency and for which a good deal of the possible gain must be resigned. In addition, thermal improvements cause increases in first cost, for which interest, depreciation and other fixed charges must be paid, which in many cases are not paid for by the saving in fuel. Thus it would be incorrect to consider financial economy equal to the saving of thermal units alone. The real measure of the economy obtained by installing improved equipment is the dollars and cents saved after all charges caused by the improvement have been taken into consideration, and the net saving becomes the difference between the dollars and cents equivalent to the saving in fuel and the additional expense caused by interest and other fixed charges on increased first cost, both considered over the same time period.

Thermal savings (in cents per kilowatt-hour) result from the saving of coal (in B.t.u. per kilowatt-hour) multiplied by the coal price in cents per B.t.u. If expensive coal is burned in a power plant, obviously the savings of coal are much more important than if cheap coal is used.

The additional costs per kilowatt are largely affected by the amount of increased first cost, the kilowatts of installed capacity, the load factor and the total rate of interest and other fixed charges.

In special cases, where all details of prices are known, it is easy to obtain figures for both saving and additional cost per kilowatt-hour, and the difference can readily be found. In the more general case the fuel saving in B.t.u. may be calculated, but the permissible additional first cost that the calculated fuel saving will economically permit is an unknown and a desired quantity. The accompanying chart is designed to aid this determination, and is based on the equation derived as follows:

Specific savings of fuel, f B.t.u. per kw.-hr.

Installed power, N kw.

One year has 8,760 hours.

Load factor of power plant, a.

Energy produced per year, $(8{,}760 \times a \times N)$ kw.-hr.

Fuel saved per year, $(f \times 8{,}760 \times a \times N)$ B.t.u. per year.

Fuel price per thermal unit, P dollars per million B.t.u.

Financial saving per year, $\left(\frac{f \times 8{,}760 \times a \times N \times P}{1{,}000{,}000}\right)$ dollars.

Total rate of interest and fixed charges z per cent.

The above calculated financial saving per year corresponds to the interest and fixed charges on the following capital:

$$\frac{f \times 8{,}760 \times a \times N \times P}{1{,}000{,}000 \times \frac{z}{100}}$$

which is the maximum allowable amount that may be invested in an improvement resulting in the fuel saving of f B.t.u. per kw.-hr. Referring this capital to the installed capacity of the plant, the expression for the allowable investment per kw. becomes $0.876 \times f \times \frac{a \times P}{z}$ on which the chart it based.

To illustrate the use of the chart and to show the effect of the various factors entering into the calculation, two examples are given in both of which the saving in fuel has been taken as 1,000 B.t.u. per kw.-hr. The assumed values are given in the following table:

	Case 1	Case 2
Load Factor	0.9	0.3
Fuel cost, dollars per million B.t.u.	0.3	0.1
Rate of interest and fixed charges, per cent	8.0	20.0

Starting with the fuel saving on the horizontal scale, drop down vertically to the diagonal line corresponding to the load factor, then proceed to the left along a horizontal to the diagonal line corresponding to the fuel price; from this point continue vertically to the diagonal line in the third square corresponding to the interest rate. A horizontal from this point will intersect the vertical scale at the economical limit of first cost.

The two examples show that under favorable conditions $29 per installed kilowatt may be expended for an improvement saving 1,000 B.t.u. per kw.-hr., while under less favorable circumstances only $1.30 per installed kilowatt may be expended. Thus, with the same fuel saving, the actual economy may vary widely with conditions, such as load factor, fuel price and rate of fixed charges.

Economy is a matter of *money* and not of *thermal units*, and it would be a mistake to be guided only by a thermal point of view.

Stopping Air Leaks in Boiler Settings

By James Hobart

Every brick boiler setting admits some air, for the presence of which economy suffers accordingly. If one will test each joint in the brickwork with a lighted candle the candle flame will be drawn inward by the air current if there is any leakage through any crack. Pointing the cracks with lime mortar, applied by a very small tool, known as a "pointing trowel," is the usual way of treating boiler-setting brick joints, but is probably the least effective method of all. A film of mortar may close the leak for the time, but it soon yields to expansion and vibration and permits some air to get past. Lime mortar may be used, as may cement mortar or a cement made and sold expressly for the closing of leaks in brickwork.

The writer, however, prefers a mixture of calcined plaster; that is, plaster of paris, tamped into the joints immediately after being prepared. Such a filling will adhere to the bricks, and a joint well filled with that material is air-closed to stay.

Do not mix more than can be pushed into the cracks in four or five minutes, for the plaster is quick setting and may harden before it can be used. It may be made to set very slowly by mixing it with vinegar instead of water. By using a mixture of the two liquids, any desired slowness of setting may be obtained.

Do not try to apply the plaster mixture by pointing it into place with a trowel. Fill the cracks from bottom to top and tamp the plaster into place thoroughly, using a piece of brass or a wooden tamper.

If desired, much of the glaring effects of new white plaster in old brickwork may be avoided by mixing red or black pigment with the dry plaster and thus causing the new crack fillings to approximate the color of the old brickwork.

The Piping of a Boiler Oil Installation should in all cases be full-weight wrought iron or steel. The lines should be run as directly as possible without any sags and should be slightly pitched toward the supply tank. After installation the entire pipe layout should be tested to 150 lb. per square inch.

A 1,000-Pound Boiler

Furnishing Process Steam

WHILE power boilers are operating at 1,200 to 1,400 lb. in two central stations in this country, the boiler here shown operates at the highest pressure to be employed thus far for process use. It is installed in the plant of the Mason Fibre Co. at Laurel, Miss., and furnishes steam for the manufacture of Presswood, which is a sawmill waste product.

Briefly, the wood chips are cooked for 10 to 15 seconds under a pressure of 200 lb. after which the valve is fully opened and a pressure of 1,000 lb. is held for 3 to 5 seconds. The contents of the container are then suddenly released, which causes the chips to explode and produce a wood pulp of long fibers. This is then pressed into fiberboard.

The boiler is a 4,000-sq.ft. Babcock & Wilcox cross-drum type having 2-in. tubes, 3/8-in. thick. As in the case of the Edgar and the Lakeside boilers, the drum is from a solid steel forging, with drawn ends. It is 4 ft. in diameter and the metal 4 in. thick.

EDITORIALS

F. R. LOW, *Editor*

Water-Cooled Furnaces

A BIT of interesting history in the development of water-cooled furnaces as experienced in the stations of the United Electric Light & Power Company, is revealed by Mr. Leitch in this issue.

When one considers the comparatively short time that has elapsed since such water-cooling was undertaken, the wide application it has attained is quite remarkable. That the idea did not receive earlier attention in stationary practice, in spite of long experience with Scotch boilers in the marine field, may be wondered at, but, as in most cases, the old adage of "necessity being the mother of invention" here applied. It was the demand for continued high rates of forcing large boilers with the accompanying high temperatures that rendered the refractory problem acute. Not only was it a matter of high maintenance cost, but outages on these large boilers proved a serious matter.

As Mr. Leitch points out, it was believed at first that an all water-cooled furnace would lower the furnace temperature to such an extent as to interfere with proper ignition when operating at low outputs, but this appears not to have been borne out in practice.

Opinion is still divided among engineers as to the relative merits of walls made up entirely of unprotected water tubes and those in which the tubes are protected by a thin layer of refractories. Both appear to be giving satisfaction, and the choice must be left to local conditions tempered by personal preference. It is significant that equipment manufacturers are now receiving many requests to figure on boiler installations to have capacities up to 350,000 pounds of steam per hour. Without the water-cooled furnace this would be impossible.

An Indictment

A WELL-KNOWN consulting engineer, in a report on the boiler plants of one of our American cities, makes the following statements: "The co-operation of the owners or managers in every case has been splendid, the chief difficulty being that they have given little or no attention to coal-burning equipment, methods of operation, grade or size of coal burned, having left these matters to the firemen, who in the majority of cases are hired on the basis of their physical development and have lacked intelligence, information and above all have no desire to work. The manager has purchased the cheapest coal per ton, little realizing that the possibility existed of buying a coal or fuel which might cost him slightly more per ton but less per year to operate." In another part of the report, "The filthy, dilapidated and unkempt condition of the majority of the boiler plants in the city indicate a lack of interest." These statements, in addition to constituting an indictment against the management of the particular plants in question, point out a situation that exists in many other places.

The responsibility for such conditions is not hard to place. It rests entirely with the plant management. Too long have the boiler and furnace rooms in many plants been regarded merely as necessary evils, and been given only enough time and attention to keep things moving.

How long will it take some owners or managers to realize that the fireman in the boiler room is largely responsible for the use of the coal which represents a very large part of the cost of heat or power? His ability, interest and performance determine whether the fuel is utilized efficiently or whether a considerable portion of it is wasted. And yet, in many cases more care and attention are given to the selection of an office clerk, whose pay may be more but who has no particular responsibilities, than to the selection of the fireman who may either utilize efficiently or waste the value represented by the coal pile.

And in addition, as pointed out in the quotations from the report mentioned, a vast number of plants still are good examples of poor plant housekeeping. It is admitted that it is a difficult matter to keep the insides of many boiler and furnace rooms in tiptop shape, but there is absolutely no reason why any boiler room cannot be maintained in a light, clean and orderly condition, and the owner or manager should see that this is done.

The fireman, too, should realize that he has certain responsibilities in the operation of the plant. His job is not merely a strong-back one, but calls for an unusual degree of ability, skill and knowledge. Usually, the quality of his work is reflected by the condition in which he keeps his plant. A good fireman is usually a good plant housekeeper. Unfortunately, we have too few of this kind.

The situation generally, however, is not so bad as the report indicates. Much progress has been made, especially during the last few years, in cleaning up plants and improving plant conditions generally. More owners and managers are taking a keen and active interest in their power plants, obsolete and worn-out equipment is gradually being replaced with that which is new and up to

date, and the fireman's work is being given at least a part of the consideration to which it is entitled. But there is still much to be accomplished, and no owner, manager or fireman, regardless of how good his plant or how well managed it is, can afford to "rest on his oars."

Factors in Efficient Elevator Service

IN THE design of modern passenger elevators a great deal of attention has been given to obtaining high car speeds, increasing the rates of acceleration and retardation and providing a control that, along with other features, allows making accurate stops at landings. All this has been done for the purpose of increasing the efficiency with which passengers may be handled. A factor that, too frequently, is not given proper consideration in providing elevator service is that the elevator itself is only part of the equipment essential to rendering an efficient service.

Of almost equal importance to the elevator machine and control are the signal system and landing doors. Unless adequate means are provided for waiting passengers to communicate their desires to the operator and to call the attention of passengers to approaching cars, the efficiency of the service will be decreased. If elevators are delayed at landings due to the passengers not being ready to board waiting cars, it is the equivalent of slowing up the car. There is little use of increasing the car speed if, owing to a poor signal system, the time gained by increased speed is lost at the landings.

The prime object of passenger elevators is to render service to occupants of a building, and the installation of a signal system properly designed to meet these conditions increases the efficiency of this service. If the signal system fails to operate when a waiting passenger presses a landing button, the car may go by without stopping. On the other hand, if passengers are left at landings, due to their attention not being attracted to the cars going in the direction they wish to go, the effect is almost as bad as if the car did not stop. Such conditions result in the dissatisfaction of those who occupy and use the building. Inadequate signal systems cause false stops, which slow up the service and increase the power consumption.

In rendering efficient elevator service the landing doors play an important part. They should be so arranged that they can be quickly and safely opened and closed by the operator. If manipulating the doors seriously fatigues the operators, it can scarcely be expected that they will make the same effort to give service as when conditions are made favorable for them to perform their work. Where the doors are power operated or at least self-closing, the operators are able to give more attention to the passengers' needs and safety. Interlocking the doors' operation with the control also assists in speeding up the safe operation of the car, and relieves the operator of a large part of the responsibility for the passengers' safety.

An elevator machine is like any other equipment, in that its efficiency depends largely upon the efficiency of its component parts and those who operate them. Inefficient equipment cannot be expected to develop efficient attendants. If the signal system fails to function properly, the operator is likely to use this as an excuse for neglecting his work; or if the landing doors are difficult to manipulate, they become an excuse for delaying the car at the landings. Consequently, if an elevator equipment is to be efficient, all parts of the installation must be designed to render a satisfactory service and be properly maintained—a fact too frequently overlooked.

Information or Education

A MEMBER of an engineering association, in discussing the activities of the educational committee of his society, said, in effect, that the members did not want *education*, but wanted only *information*. If this statement represents the frank opinion of the membership on the work of its educational committee, the society should take heed that it is deliberately missing one of its golden opportunities and is shirking its responsibility to the younger members and to those young men who will follow in their steps.

The younger men should consider seriously their attitude on this matter. Just what are the fundamental differences between what has been termed *education* and *information*. An educated man has been taught to think, to reason, to use his brain, and has the mental equipment to form good judgments and to be master of the principles and practices of his chosen line of work. The man with no stock in trade other than an endless supply of facts and information is in a different situation. Unless his mental machinery has been properly trained, the chances are that he is unable to use his facts or information efficiently. He is a workman with a chest of tools that he does not know how to use; he cannot even find them. On the other hand, a man who knows how to use the tools, usually has little trouble in finding them to work with.

A careful distinction should also be made between *training* and merely *memorizing*. Usually a well-trained mind retains certain fundamental facts, but it is not a storehouse for facts, figures and receipts. These can better be kept in records and books and found when wanted. A man who tries to get by, simply by depending on his memory, can in no way compete with one who has a trained mind.

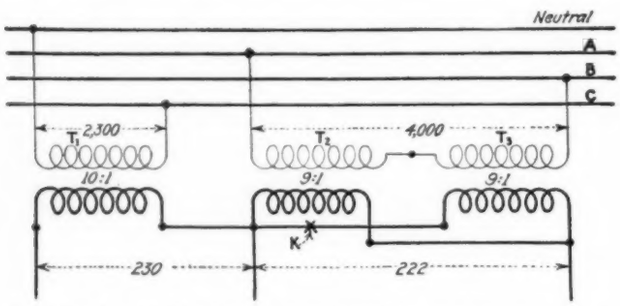
The younger men should not be misled by a propaganda for nothing but information, for information, without training, amounts in the end to little. Promotions, responsibility and advancement come to the well trained and not to those whose stock in trade is information alone.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Two-phase Motor Operating on Unbalanced Voltage

Some time ago I had occasion to investigate the electrical installation in a power plant that was equipped with two-phase motors, and was informed that considerable difficulty had been experienced in starting up these motors. It was found that the electrical supply was from a bank of three transformers connected to furnish



Standard transformers connected to supply two-phase power from a three-phase line, with voltages obtained

two-phase power from a three-phase line. The transformation from three-phase to two-phase was accomplished by using standard transformers having 9 to 1 and 10 to 1 taps and connected as shown in the figure. To use the arrangement shown, the primary must be four-wire Y-connected, and transformer T_1 must have a capacity equal to the sum of the capacities of T_2 and T_3. Transformers T_2 and T_3 are of equal capacity and have 9 to 1 taps.

Voltage readings were taken at the motor terminals and at the point where service entered the building. These readings showed a 60-volt unbalanced between phases and also showed that the source of trouble was outside the plant, probably at the transformer bank.

Upon checking up the transformer connections, it was found that on the secondary side of the bank one wire used to parallel the secondary coils of T_2 and T_3 was broken, as at K. As a result of this break the secondary coil of transformer T_3 was cut out of the circuit, and the primary acted only as an impedance in series with T_2. If it were attempted to draw a heavy current from T_2, as in starting a motor on the line, the impedance drop across T_3 would be a large part of the voltage of the primary circuit. The voltage at the load on the phase supplied by T_2 would therefore be so low that the motor would be starting practically as a single-phase machine, which accounts for the trouble. Also when the motor had started it probably ran mainly as a single-phase machine and tended to equalize the phase voltages. Actually, the motors required manual aid in starting, but continued to run and carry their load without excessive heating. When the broken wire was repaired, the secondary voltage became normal, and the motors would start up unassisted under load.

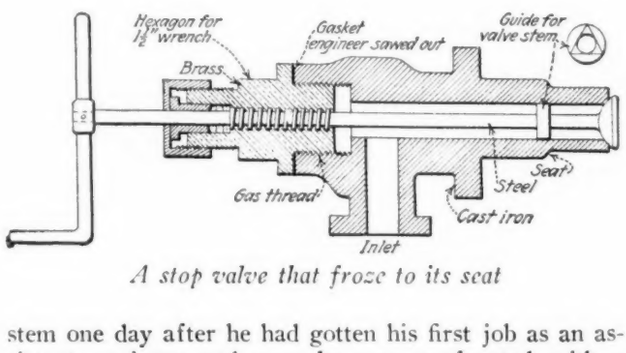
Flushing, N. Y. GEORGE I. MACKENZIE.

Freeing a Frozen Air Starting Valve

In an institutional power plant two double-cylinder producer-gas engines were installed, carrying the day and night load and running alternately all the week, from Sunday night till the next Sunday morning.

One Sunday it happened that engine No. 2 had to be put in operation again after having been in service during the week-end. The other engine was down for repairs. When the watch engineer came on duty he found both starting air valves closed instead of open, as ordered by the chief, who had had some previous experience with this type of engine. Compressed air for starting was mechanically timed, but was turned off after the first explosions by means of a hand-operated stop valve, as shown in the illustration. It is obvious that the stop valve was heated during operation and of course was tightened enough to keep it from leaking. If not turned open immediately after stopping the engine, the valve stem cooled and shrunk in length, thereby locking the valve to its seat. On this particular occasion the watch engineer was unable to open the valve of the right-hand cylinder. He had tried everything, including heating the valve and finally sent for the chief engineer.

The chief himself had broken an air-starter valve



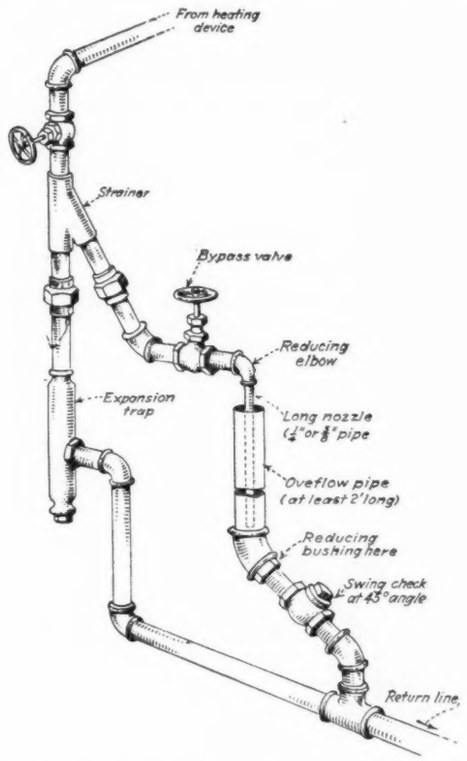
A stop valve that froze to its seat

stem one day after he had gotten his first job as an assistant engineer and now he was confronted with a similar problem. For a moment he considered starting the engine by turning the air on the left-hand cylinder only. On second thought, however, he took a hacksaw and removed the gasket between the brass valve-stem bushing and the cast-iron valve body; this enabled him to screw the bushing down to the cast-iron body and free the valve from its seat. The threaded part of the stem was lubricated with oil and graphite, and after assembling the valve was ready for service again.

Ensclede, Holland. H. WEILAND LOS.

Limiting the Use of the Bypass on Steam Trap Lines

There is no doubt that a bypass is a necessity on all steam traps of the float type as well as on some types of expansion traps. On large jacketed heating kettles or finishing rolls, which stand over night with no steam on, a bypass clears out accumulated water to get the device started in much less time than if the trap were



Arrangement of trap with overflow pipe on bypass connection

allowed to function alone. However, I believe there is more steam wasted on such installations in the majority of plants than through any other source, which can easily be saved.

The commonest cause of the bypass being misused is forgetfulness on the part of the average employee, although in many instances I have found men turning on a bypass and leaving it open deliberately, having no interest in securing more heat on their machines or in saving steam. Still one will find an occasional "old timer," especially on heated finishing rolls, who believes he can secure more heat by letting the steam blow freely through the roll. Regardless of what the cause may be, a simple remedy can be effected in most cases where there is sufficient drop between the supply and drain lines to install an open overflow receiving pipe at least 2 ft. long vertically, as shown in the illustration. Two advantages are gained by this method of piping. It first provides a positive means of reminding the operator that he has left the bypass open, for as long as there is any condensate in the line above the bypass valve it will easily be blown down the overflow pipe and into the drain line through the check valve, which is set at an angle of 45 deg. so that it will be just about seated, yet opened with the slightest pressure on the upper side or closed with the least back pressure on the under side. As soon as the line has been cleared of water, vapor will immediately rise from the open end of the overflow pipe.

The second feature of this arrangement is the frequent blowing out of the strainer above the trap—and right here let me say from considerable experience with expansion traps that their success for constant satisfactory operation depends on keeping all scale or dirt out of the valve chamber, and a suitable strainer ahead of each trap soon pays for itself with uninterrupted service of the trap. Often, where strainers are installed, they may be forgotten until the screen becomes completely clogged unless a rigid system of trap inspection is carried out, which is seldom done in most plants. While this arrangement is simple, it is of considerable importance that the check valve be set at the angle shown, for if set in horizontal position, the overflow pipe would be likely to run over before the check would open, unless the riser was long enough to give a column of water sufficient to overcome the weight of the check in closed position.

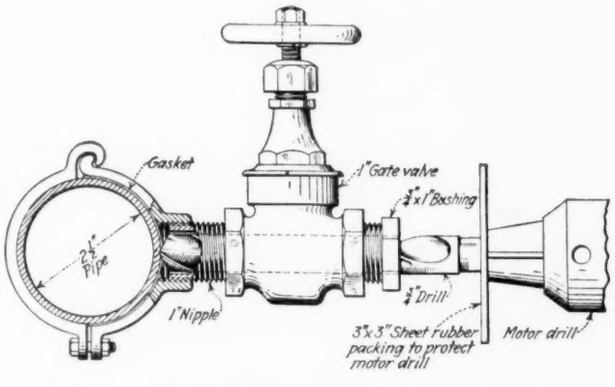
P. T. Van Bibber.

Newark, N. J.

How New Connections Were Made to the Brine Lines Without Draining the System

Some time ago we installed an extra brine coil in one of our basement ice boxes and had to tap the main brine supply and return lines. The method we used to make the connection is shown in the illustration.

First, we installed a 2½x1-in. service pipe saddle on each pipe with a gasket below the connection side of the clamp. Then we made up a 1-in. gate valve with a 1-in. nipple and ¾x1-in. reducing bushing, as shown, and screwed this into the clamp. To make the opening in the pipe, we inserted a ¾-in. straight-shank drill through the bushing, using a 3x3-in. piece of rubber as a protection for the electric motor. When the hole was



Drill in position for putting opening in pipe line

through the pipe, the drill was withdrawn and the valve closed, the whole job being done without losing more than a quart of brine. We then proceeded to make up the rest of the line to the coil with ¾-in. pipe.

We did not shut down the brine system or drain any part of it. By using this method, we saved the time and expense of draining the system and recharging it again. The job required about three-quarters of an hour, which is much less than would have been necessary to do the job in the usual way.

Lawrence B. Brown.

Los Angeles, Calif.

COMMENTS *from* READERS

Why Safety Valves Chatter

I have been much interested in the No. 6 question, "What makes a safety-valve chatter?" and the answer, which appeared in the "What Do You Know" column in the May 10 issue, likewise with the discussion of the subject by J. W. Tracy in the June 7 issue.

In March of this year I installed a safety valve 3-in. in diameter, 6,600 lb. capacity and with a 5-lb. blowdown. It was set to blow at 100 lb. This valve chattered so severely when it opened that the vibrations could be felt on the shell of the boiler. This worried me, and I immediately attached a cord to the lifting lever, and this stopped the chatter when it was held taut by the attendant.

In the meantime I studied the application and design of this valve and found that there was a cast-iron nozzle riveted to the shell, 3½ in., O.D., by 8 in. long, but the inside diameter was only 2¼ in. The old valve was 3 in. in diameter, therefore I ordered one of the same size, although our Inter-Provincial Regulations Formula sanctioned a 2½-in. valve. I assumed that a 2½-in. valve would have functioned without chatter, as the capacity of the new valve was too large, it having a tendency to open and partly close, creating the noise.

I experimented with lowering the amount of blowdown by raising the ring. This aggravated the chatter, reduced the warn-time and made the valve open sooner.

I then reversed the adjustments, lowering the blowdown ring until the valve had 6½-lb. blowdown. This increased the warn-time, also the popping point to 102 lb., but the chatter was decreased somewhat.

Upon reading the answer to Question No. 6, I went further by increasing the blowdown to 8 lb. This resulted in a longer warn-time, popping at 104 lb. and a remarkable decrease in the chatter.

The increased amount of blowdown was not desirable, as the boilers were limited to 165 lb. hydrostatic test pressure, allowing us 105 lb. working pressure, with a variable load of steam-driven compressors which frequently cut out for three or four minutes, then cut in for an hour or more. Distant steam-driven pumps with poorly insulated steam lines required as high a pressure as we could maintain that they might work at their maximum capacity. Therefore, the 8-lb. blowdown was wasteful of fuel.

Wood fires are not easily checked and on light load the safety valve would open. The compressors would cut-in in their respective order, interfering with the pumps' capacity, requiring fires to be forced harder to regain the desired operating pressure when the safety valve closed.

My findings are partly as stated in the answer to Question No. 6, in that the popping point would be raised. Had there been space, the answer would probably have included other effects the adjustment created.

Winnipeg, Canada. ERNEST CASSON.

Compression Stops Eccentric Heating

A large Corliss engine gave considerable trouble from heating of the eccentric, and every known method of lubrication was used to overcome it. The steam pressure was usually 130 lb., and the valve setting was considered good, compression being carried to one-fourth the initial pressure, as recommended by the builders. However, it was noticed that on Saturdays when the load was light and the boiler pressure dropped to 100 lb., the trouble disappeared.

With less unbalanced pressure on the steam valves the load on the eccentric was reduced, and it was decided to increase the compression to the maximum point. The eccentric was advanced and the next set of diagrams taken showed the compression to be 115 lb., or over 80 per cent of the initial pressure. The radial rods had to be lengthened on the exhaust valves to keep the point of release unchanged, and the steam radial rods were lengthened to prevent early admission and excessive lead. The heating of the eccentric disappeared and the engine ran better, a slight groaning in the valve gear disappearing at the same time with less cylinder oil used.

Increasing the compression on another Corliss nearly to boiler pressure reduced the steam consumption considerably and eliminated a loop that had always appeared on the release end of the diagram. This engine was lightly loaded, and for quiet operation they were in the habit of partly closing the throttle as the boiler pressure had to be kept up. With the throttle only partly open and the engineer away from the engine room much of the time a drop in steam pressure would cause a reduction in the amount of steam passing the throttle, and the engine would slow down; sometimes the governor would drop to the lowest position and shut the engine down before the engineer had time to get there. Increase of compression gave a slightly later cutoff, which held the expansion line above atmosphere and eliminated the pound due to the exhaust valves lifting from the seats.

It may seem queer that the engine used less steam with later cutoff, but it should be kept in mind that the clearance was filled with steam at the time the steam valve opened, so that no steam was actually admitted till the piston started the return stroke, and the steam entering and mingling with steam that was as hot or hotter, was more available for expansion, as less was lost through initial condensation.

I have often been asked if it pays to increase the compression on all engines. If the load is light so that the cutoff is too early to secure the best steam rate, then a gain is made by higher compression, especially if throttling has formerly been resorted to. But if the engine is loaded so that the cutoff is beyond the economical point, then higher compression is of no advantage unless the initial pressure can be also increased, as the evil of too late cutoff is aggravated by this action.

Thompsonville, Conn. G. H. HART.

Fineness and Structure of Pulverized Coal

If the conclusions given in the paper by P. Rosin and E. Rammler on "Fineness and Structure of Pulverized Coal," an abstract of which appeared in the March 15 issue, can be admitted as correct or nearly correct, they materially aid the solution of practical problems relating to the application of pulverized fuel, because they supplement conclusions drawn as a result of flame propagation tests in which the fineness of the fuel was not materially altered.

The authors recognize the fact that there are two phases to the process of pulverized-fuel combustion—ignition and completion of combustion.

These two phases are so closely related that they overlap when the powdered-coal flame is considered as a whole; that is, the completion of combustion of the finer particles serves to ignite the coarser particles.

It has been observed in practice that the rapidity of

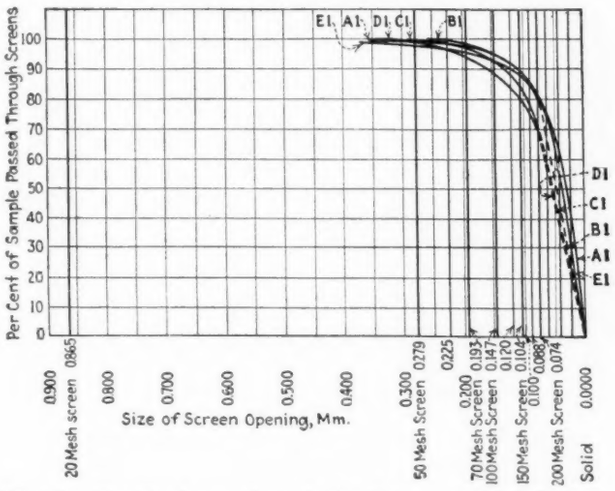


Fig. 1—Graph shows the relation between size of screen opening and percentage of material through, as given in the table

ignition is a function of the fineness of pulverization, while the completion of combustion is a function of the coarseness of pulverization.

When lighting a pulverized-coal fire, the surrounding furnace walls are usually cold; therefore, the safety of the operation is determined by the ability of the equipment to sustain continuous ignition. At this time completion of combustion is desirable but is not essential.

After the furnace becomes hot, completion of combustion becomes essential and the exact point of ignition is of secondary importance so long as it takes place beyond the nozzle of the burner and is not so long delayed as to affect the length of flame materially.

The completion of combustion is governed by so many factors that it is impossible to state, as the authors have done, the coarseness that is permitted by practice. (J. Gould Coutant, *Combustion*, Nov., 1926.)

The importance of the paper is confined to the data which aid the solution of ignition problems.

Arnould De Grey found (*Revue de Metallurgie*, Nov., 1922, No. 11) that pulverized fuel showing a residue of 25 to 35 per cent on a 200-mesh screen did not show appreciably lower rates of flame propagation than fuel all of which would go through this 200-mesh screen. This would indicate that all the mixtures reported by De Grey contained a sufficient number of extreme fines to permit the rates of flame propagation as observed and the conclusions of the paper show that this condition would be obtained irrespective of the kind of pulverizer or grade of fuel.

The data presented in this paper are hard to reconcile with the major conclusion which is stated: "The composition of pulverized coal is practically independent of the kind of coal, method of grinding and separations." However, the use of the word "practically" indicates a reservation, and the data presented, although they do not technically bear out the conclusion, show limits within which the distribution of fines may be supposed to lie.

Fig. 1 shows graphically the relation between size of screen opening and percentage of material through for the five kinds of fuel ground on the Polysius tube mill. To make the conclusion stated correct, these curves should lie parallel, but actually they cross each other, which shows that the composition of fines is not similar in the various samples.

In an article in the April 19, 1927, issue, Guy B. Randall has suggested a fineness ratio method of specifying pulverized coal. This same thing was reported in *Mechanical Engineering*, May, 1925, by calculating the percentage of 200-mesh material in samples, all of which were assumed to go through 100 mesh. This method of attacking the problem gave percentages of fineness ratios from 47.0 to 92.5 in the seventeen different samples. The fineness ratio method would give the following results for the samples listed in Table I of the Rosin and Rammler paper, assuming their 127-mesh screen as a base:

KINDS OF COAL TESTED, PERCENTAGE THROUGH 127 AND 200 MESH SCREEN AND FINENESS RATIO

No.	Kind of Coal	Per Cent Through 127 Mesh	Per Cent Through 200 Mesh	Fineness Ratio
A-1	Westphalian high volatile	92.8	80.9	87.2
2		96.0	87.6	91.3
3		93.9	80.6	85.8
4		98.8	92.1	93.2
5		98.8	93.7	94.7
B-1	Westphalian low volatile	92.8	80.4	86.6
2		92.8	79.6	85.7
3		99.6	94.0	94.4
14		99.2	94.4	95.4
C-1	Saxony anthracite	88.8	72.8	81.9
2		90.0	76.4	84.9
3		99.2	93.9	94.8
4		98.8	95.0	95.9
D-1	Briquets	84.8	69.8	82.4
2		93.0	81.7	87.8
3		98.0	89.7	91.5
4		99.2	95.4	96.3
E-1	Rhenish brown coal	90.7	80.4	88.8
2		94.0	83.2	88.4
3		97.6	89.7	91.7
4		97.2	90.3	93.1

Plotting the percentage of material through the base screen size against the fineness ratio gives points so widely scattered as to be practically valueless, although the general trend of the curve shows that increasing the percentage through the base screen will result in an increase in the fineness ratio. Several points do not follow this rule. If all points were in accordance with this rule, the correctness of the conclusion would be demonstrated.

It might be well to point out here that the fineness ratio cannot be used as an index of the degree of pulverization without also stating the percentage of material which passed through one of the screens. As an illustration, a sample showing 95 per cent through 100-mesh and 85 per cent through 200-mesh has the same fineness

ratio as a sample showing 50 per cent through 100-mesh and 44.7 per cent through 200-mesh. Obviously, the former sample is better pulverized coal.

The correctness of the experimental data reported by De Grey has been proved by the performance of burners in actual use with fuels covering a wide range of volatile matter and ash content. An example of the practical application of these experimental data is shown in Fig. 2, which is a photograph of powdered fuel burning in the open with a surrounding air temperature below the freezing point. Cambria County, Pennsylvania, coal was used for this test, showing 18.7 per cent volatile combustible matter, 4.8 per cent moisture and 7 per cent ash. The coal-feed rate at the time of taking the photograph was 1,350 lb. per hour. The fineness sample showed 100 per cent through 20-mesh, 93.9 per cent through 100-mesh and 81.1 per cent through 200-mesh.

The minimum amount of coal feed at which continuous ignition can be obtained is determined by the ratio of primary-air volume to quantity of coal. Tests have

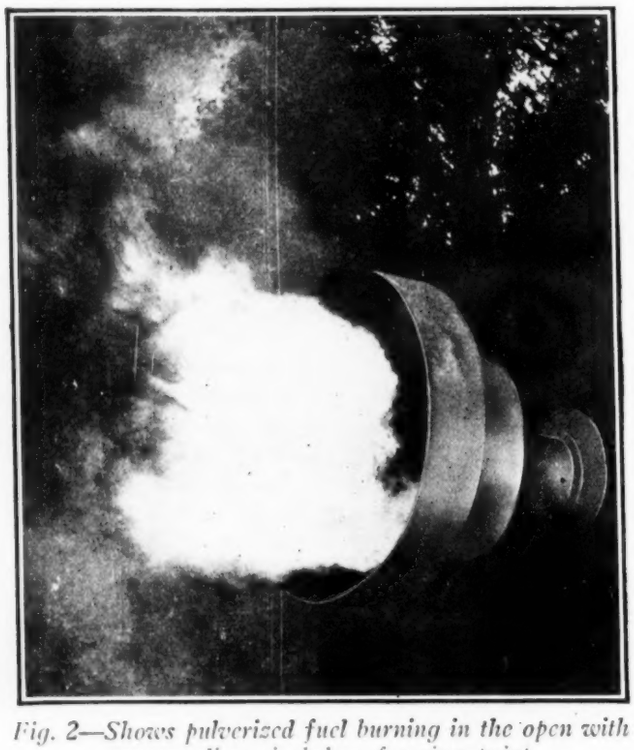


Fig. 2—Shows pulverized fuel burning in the open with surrounding air below freezing point

shown that continuous ignition can be obtained at a coal feed rate of 800 lb. per hour on a burner that is capable of handling a 6,000-lb. per hour peak. Performance at all intermediate points confirms the experimental data referred to in the foregoing.

Mr. Randall has suggested the desirability of quoting power consumption and moisture content, as well as fineness figures when writing articles of this kind.

It has been found in actual practice that the power required to pulverize the coal is only a small portion of the total power required to drive the pulverizer and its fan. Messrs. Riley and Craig in the November issue of *Mechanical Engineering* analyzed this condition and found that the power required to drive the pulverizer and fan was practically constant for any given machine, while the power required to pulverize the coal varied directly with the rate of coal feed for any given fineness of pulverization or grade of coal. They also found that the total power consumption per ton depended upon the rate of pulverization.

The total power consumption of a pulverizer cannot be used for purposes of comparison against another pulverizer unless the grade of coal is the same and a correction factor is used for greater or less discharge pressures. The publication of power consumption figures are useless unless they can be reduced to some base that is constant for all pulverizers. Such a base would be provided by a pulverizer efficiency curve.

Probably the best way to attack this problem would be to ascertain the degree of grindability of the coal by making laboratory tests.

Wilhelm Schultes says (*Archiv fuer Waermewirtschaft*, February, 1927, p. 41), "Since pulverized coal of like granular size, but of various kinds of coal exhibits a varying time for combustion, an investigation should be made to determine to what extent the physical characteristics of the various kinds of coal are a determining factor for the necessary fineness of pulverization, and to what extent economic consideration should be accorded these differences."

The establishment of grindability values for different grades of coal will give a base from which the efficiency of the pulverizer can be calculated, and this, in turn, will permit direct comparison with other pulverizers. The problems of comparison of volumes and pressure requirements of the pulverizer fan are capable of mathematical solution, therefore, should not prove troublesome.

Worcester, Mass. L. V. ANDREWS.

Undercutting a Commutator Not Always Necessary

I am inclined to think that Mr. Reardon, in his account of generator armature trouble, and enumerating the various things that were done before the manufacturer's representative took his "one look," did not give all the facts of the case, in the article "Why the Exciter Failed to Generate," June 28 issue. He says that the commutator was turned down, as one of the first things done. If this was properly done, using a sharp tool and at the correct rotative speed for copper, the mica would be flush with the copper and would not interfere with good commutation.

Undercutting of the mica, while at most times advisable, is not absolutely essential. In several hundred cases of commutator turning, ranging from small sizes to large direct-connected units, I have, after an inspection to make sure that no particles of copper were bridging the mica, in many cases put the machine directly into service. In other cases I have put the armature into service when the undercutting was only partly completed, because of insufficient time, trusting to complete it when occasion offered. I recall no failure to operate on that score.

Chicago, Ill. S. M. QUINN.

Why Do the Boilers Shake?

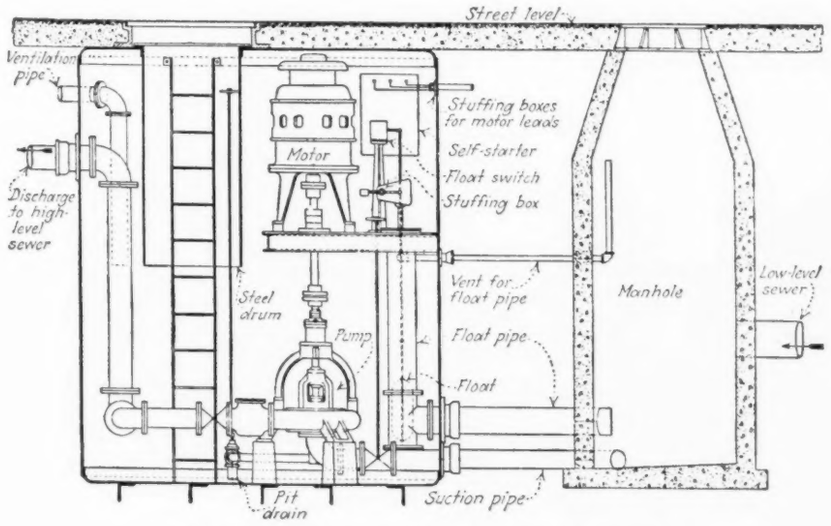
If L. D. Hewlett, who stated in the July 5 issue that he had experienced trouble from boilers shaking, will install a perforated pipe inside the boiler to act as a drier for steam, I believe this will cure his trouble from shaking boilers. Such a change will not cost much. I have made it and it stopped the trouble. D. L. BISHOP.

Detroit, Mich.

New and Improved EQUIPMENT

Yeomans Floodproof Sewage Pumping Station

Ordinarily, it is not desirable to locate electric motors and controlling devices used to operate sewage pumps in underground chambers or vaults where they may be injured by excessive dampness and lack of attention. There are numerous cases, however, where an installation of this kind cannot be avoided. For such cases the Yeomans Brothers Company, of Chicago, has designed a floodproof underground pumping station that will prevent complete submersion of the equipment under any conditions that are likely to occur.



Floodproof underground sewage pumping station

This floodproof principle is applicable for use with sewage ejectors and emergency pumps in municipal, city-building and power-plant work. The general arrangement is shown in the illustration. The feature of the system is that, owing to the steel drum which forms the entrance to the chamber and extends down to a point below the level of the electrical equipment, the motors and controllers are located in an air-locked space in the upper part of the chamber. Even with a considerable head of water over the top of the chamber and with the cover removed from the entrance manhole, the water in the chamber cannot rise far enough above the bottom of the entrance drum to reach the motor windings or electrical devices.

The steel wall of the chamber, where the power wires for the motors are brought in is provided with stuffing boxes, and the ventilating pipes, if any, are carried down to the same level as the bottom of the entrance drum, so that air cannot escape at any point above this level. The pit drain valve, which is connected to the suction of the sewage pump, is provided with an extension stem running up into the entrance drum, so that after flood conditions have subsided, the water remaining in the chamber can be pumped out even if it is impossible to gain access to the pit.

Link-Belt Anti-Friction Belt Conveyor Idler

The Link-Belt Co., Chicago, has recently introducted an improved type of anti-friction idler and return rolls for belt-conveyor equipment.

The outstanding feature of the idler which is mounted on tapered roller bearings totally encased within the roll hub is the protection afforded by a labyrinth grease seal, mounted in a grease cap which also serves as an outboard reservoir and lubricates the bearing on the outside as well as on the inside, especially when the roll is on an incline. This, in turn, is protected by a deflector plate which deflects dirt, or any foreign material away from the bearings and grease seal.

The rolls are mounted on a self-cleaning "T" base which is riveted in position. All rolls are interchangeable, being capable of serving in any of the three positions.

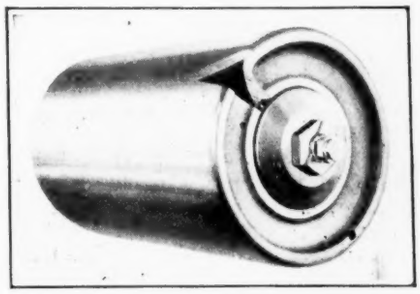
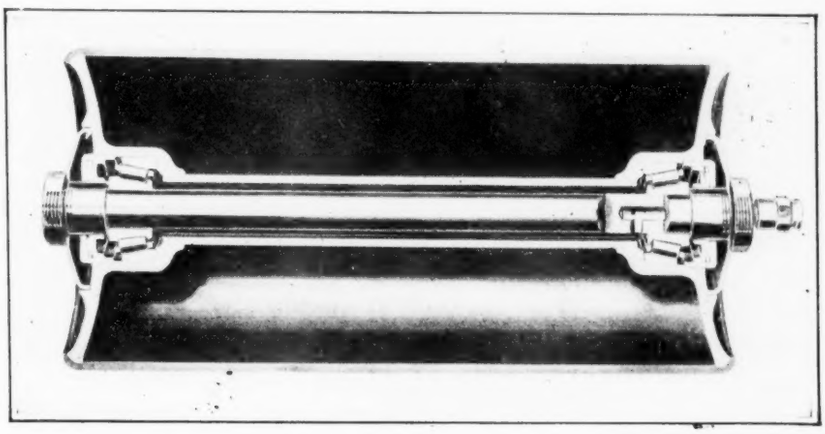


Fig. 1—Idler roll cut away to show construction

Special care is exercised in the machining of the roll shell, to obtain uniformity of thickness of the wall into which the machined heads are pressed and securely held in place by spinning. The heads are dished for rigidity and strength.

It is claimed that the design and construction of the roll makes it practical to vary the characteristics of the material used for the roll shell. A special iron has been developed for use in coke plants, that resists the corrosive action of sulphuric fumes and the abrasiveness of coke dust. Also, rolls have been granitized for the handling of salt,



Cross-section of roll showing encased roller bearings

alkali and various other materials that cause incrustation, pitting and rusting of ordinary steel or iron.

The idler rolls are supported in malleable iron brackets having large bearing surfaces and so constructed as to support the ends of two adjacent rolls, thus obtaining perfect alignment. The roll shafts are supported at both ends close to the rolls, without overhang, thus reducing the bending moment to a minimum.

The rolls are spaced far enough apart to permit convenient removal from the frame. They are made in various standard lengths and are furnished in combinations to suit standard belt widths.

Non-Segregating Coal Distributor

A new device designed to eliminate coal segregation in the stoker hopper and fuel bed and the attending operating difficulties is now being offered by Rolland Gardner & Co., Rockefeller Building, Cleveland, Ohio. Known as the non-segregating coal distributor, this device is based on the principal that

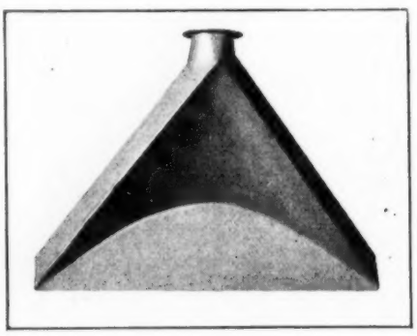


Fig. 1—Coal distributor using cone principle to insure uniform delivery

coal falling vertically on the apex of a cone having a vertical axis will divide so that every particle has an even chance of following any straight line element down the surface of the cone. Regardless of size or condition each particle will follow the straight line element on which it starts, because all elements have the same slope. For this reason no pile develops on the surface of the cone that would tend to cause the rolling of the larger particles to the sides, as in the case of the straight chute, nor is there any sifting of the fines, so that an even mixture of coarse and fine coal enters the stoker hopper and passes on to the fuel bed.

A segment of a cone will act in the same way, and as it is necessary to deliver the coal in a straight line at the stoker hopper, the cone is cut off by a vertical plane that allows the coal to drop vertically as it passes the juncture between the two surfaces. The non-segregating coal distributor is formed by adding cover and side plates and an entry at the apex. A general idea of the outline of the distributor may be obtained from Figs. 1 and 2. The photograph Fig. 1 shows the device as it would appear at the boiler front. The bottom plate, or segment of the cone over which the coal slides, appears in the foreground and the vertical apron plate, coming up to cut off the cone so that the coal will drop into the hopper in a straight line, is seen at the bottom of the illustration.

The line drawing, Fig. 2, showing a front and side view, will clarify the

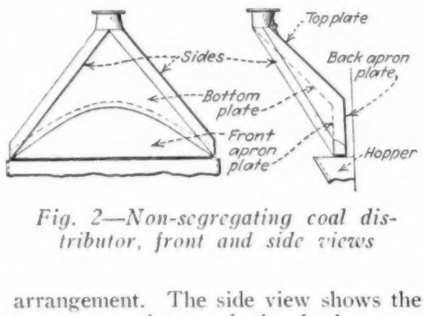


Fig. 2—Non-segregating coal distributor, front and side views

arrangement. The side view shows the top cover plate and the back apron plate, which, in conjunction with the bottom plate and the front apron plate, form the uniform passage through which the coal passes to the stoker hopper. It will be observed that the apex of the bottom plate originates at the far side of the inlet, so that all entering coal must come in contact with the conical surface of the bottom plate.

An outstanding claim for the distributor is that segregation is prevented by a device having no moving parts. It may be installed in any plant distributing coal from overhead bunkers or by larries running at a suitable height. One or more distributors may be used for a given boiler width, depending upon the height available or the number of openings that are desired from overhead storage.

Downspouts to the distributors may be vertical or they may slope toward the boiler, but if they incline laterally at an appreciable angle, means are provided to correct the segregation in the downspout itself. With the fines naturally sifting to the lower side of a lateral spout, there would be a tendency for the fine particles to follow the near side of the distributor and the coarse, the far side. This condition is corrected by inserting a spiral feeder at the entrance to the distributor, which changes the position of the coarse and fines for proper entry.

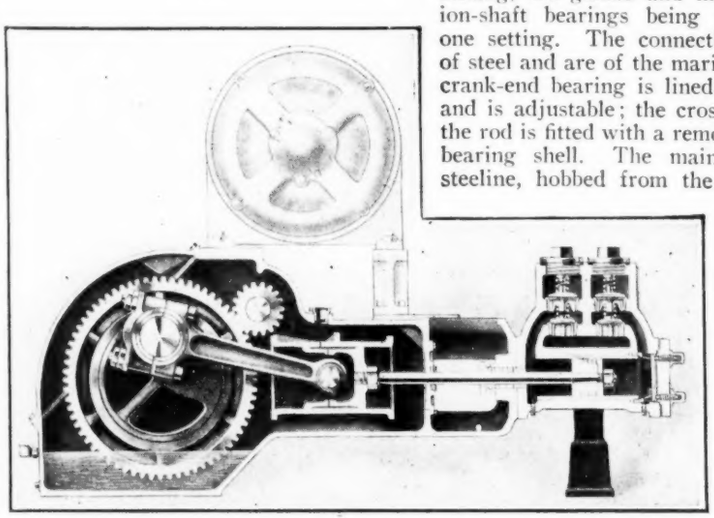
Worthington Inclosed Horizontal Duplex Power Pump

A totally inclosed horizontal duplex self-oiling power pump with double-acting pistons has been added to the line made by the Worthington Pump and Machinery Corp., 115 Broadway, New York.

The pumps, which are of the self-lubricating and semi-portable type are intended for oil-field and general medium high-pressure service. Six sizes are made, the piston diameters ranging from 2½ to 5 in., and the stroke 10 in. in each case. They are designed for capacities of 42.5 to 195 U. S. gallons per minute and for pressures of from 350 to 1,400 lb. per sq.in.

The power end of the pumps is of the horizontal self-oiling type, having the frame, the crosshead guides and the bearing supports cast integral and the connecting rods and the gearing between the main bearings. The inclosed crankcase provides a large oil reservoir. The rim of the main gear dips into the lubricant and carries oil to the top of the crankcase, whence it is distributed to the bearings, connecting rods, gearing and crossheads.

The power-end frame is a one-piece casting, the guides and main and pinion-shaft bearings being machined at one setting. The connecting rods are of steel and are of the marine type. The crank-end bearing is lined with babbitt and is adjustable; the crosshead end of the rod is fitted with a removable bronze bearing shell. The main gear is of steeline, hobbed from the solid blank, while the pinion is of machinery steel with the teeth machine cut.



Inclose power pump for medium high-pressure service

The cylinders are of steeline of the single-casting duplex type with submerged pistons and with valves accessible from above. The valve chest is cast integral with cylinder. Valves are bronze of the wing-guided type, with heavy seats driven into the deck on a taper.

New Pump is Self-Priming

GERMAN engineers have developed a self-starting pump which they claim will compete in many cases where piston pumps are now installed.

The necessity of priming centrifugal pumps before starting them has long been a disadvantage and in many cases has prohibited their use. Foot valves have done much to help this trouble but they give trouble and generally leak.

By combining the water-ring pump, also known as the Elmo air pump, with

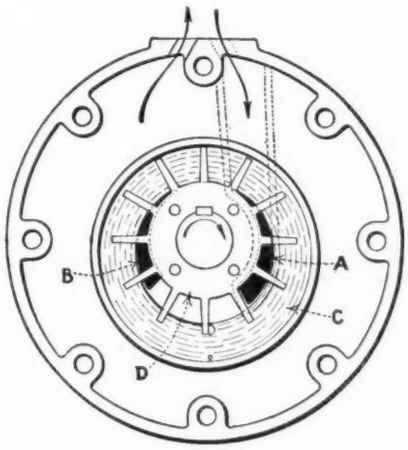


Fig. 1—Section through water ring pump.

a, inlet opening; *b*, discharge opening; *c*, water ring; *d*, impeller wheel

the ordinary centrifugal pump, a German manufacturer has built a unit which is claimed to be self-priming and self-starting, thus removing a long time limitation, and allowing the centrifugal pump to be used where, previously its application was impossible.

Operation of Pump

The operating principle of the water ring pump may be seen from Fig. 1. The pump casing with inlet and discharge openings in its side shields, houses eccentrically a radial-blade impeller wheel. When the pump is started, water in the casing is made to revolve by the impeller wheel. Centrifugal forces cause the water to form a ring, the inner edge of which touches a portion of the enlarged impeller hub. Air trapped in the openings, between the impeller blades and the water ring is carried from the suction side to the discharge side and is there forced out through the discharge openings. There is no internal leakage of air as the water forms an effective seal. This type of pump is capable of producing high vacuums and has the added advantage of being able to pump air, mixtures of air and water or water alone.

The combination of the water-ring pump with a vertical centrifugal pump is shown in the section, Fig. 2. The ring pump is contained in a housing at the end of the vertical shaft and underneath the centrifugal pump housing. The exhaust and inlet ports are in the top portion of the pump casing, thus keeping the water-ring pump always filled with water and ready for operation.

When this pumping unit is started, the Elmo pump exhausts air from the suction piping and pump casing, drawing water into the pump casing. It is claimed the priming requires but a short time and has the added advantage of being ready to reprime in case air is admitted to the pump suction.

The highest vacuum the air pump can attain depends upon the temperature of the water revolving in the air pump. As water of normal temperature is usually delivered, the temperature of the water does not greatly affect the action of the air pump. Tests have shown that a suction head of 27.5 ft. can be

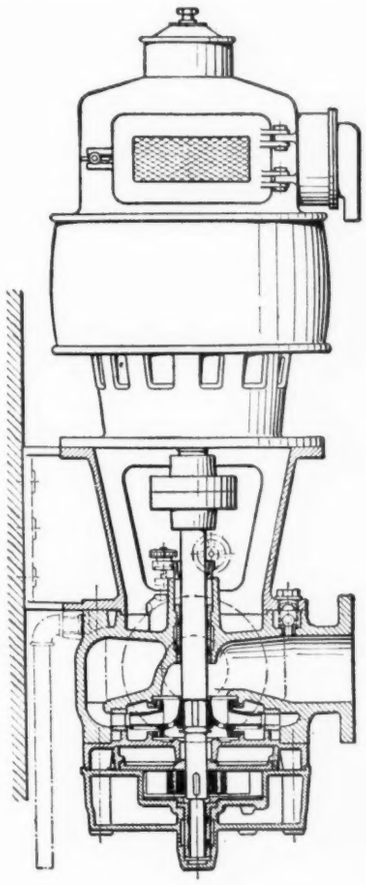


Fig. 2—Section through self-starting pump.

reached with a water temperature of 104 deg. F., while heads of 25.5 and 24 ft. are attainable with water temperatures of 122 deg. and 140 deg. F., respectively. These suction heads are sufficient for all practical purposes. The usefulness of this pumping unit for sump pumps and installations where negative suction heads exist is readily recognized.

When Is Workman Within the Scope of His Employment?

By Leo T. Parker

A review of the records of past litigations discloses that the outcome of legal controversies involving injuries to and death of employees is, in many instances, dependent upon whether the workman was "acting within the scope of the employment" at the time of the accident.

Therefore, the recent decision rendered in the case of Dambold vs. Industrial Commission et al, 154 N. E. 128, is important, because this Court thoroughly considered this point of the law, and said:

"A workman is said to be in the course of his employment when he, within the time covered by such employment, is doing something he might reasonably do while so employed, at a place where he might be while in that employment. The test relates to time, conduct and place. The words 'arising out of' indicate a causal relation. . . . There may be circumstances under which an employee, in going to and returning from his place of employment, could be held to be in the line of his employment; but such cases are governed and controlled by their own particular facts and circumstances. . . . The general rule . . . is that a man's employment does not begin until he reaches the place where he is to work or the scene of his duties, and does not continue after he has left. . . . It appears from the evidence in this case that the employment of the deceased did not begin until he arrived at his place of employment. The evidence shows that his employer did not require that he travel in a particular route in going to and from his place of employment."

The employer was held not liable.

In a Recent Report of the American Institute of Electrical Engineers attention is called to some synchronous converters that have an unusually wide range of direct current voltage. They are rated at 1,500 amperes over a range of 87 to 175 volts. The method of obtaining this variation in voltage is unique in that the alternating-current voltage at the collector rings is varied by means of tap changing on the transformer. It is necessary to change the field excitation to correspond to the different transformer taps. Voltage variation between taps is obtained by field control. The twelve-phase synchronous converter that was mentioned in the report of last year has been put into operation and two more have been built, it is stated in the report. The various advantages that were mentioned have been fully realized in actual practice, and it is not improbable that for future production the number of twelve-phase converters will exceed that of six-phase.

NEWS *of the* FIELD

International Combustion Buys F. J. Lewis Tar Company

Acquisition of the F. J. Lewis Manufacturing Co., with head offices in Chicago and known as one of the largest tar companies in the country, by the International Combustion Engineering Corp., New York, was announced July 18.

According to the statement issued by the International Combustion Corp., in addition to the control of the F. J. Lewis tar distilling plants in Newark, N. J.; Chicago and Granite City, Ill.; Fairmont, W. Va.; Dover, Ohio, and Chattanooga, Tenn., totaling a value of $8,000,000, the company contemplates the construction and operation of two coal distillation plants, in view of the decision of the company to supply a superior and smokeless fuel to both power station and domestic users and gas to companies for distribution, treating and disposing of the tars, oils, motor spirits and tar acids.

F. J. Lewis, chairman, and W. H. Lewis, president, respectively of the F. J. Lewis Manufacturing Co., will continue in their present positions, and that company will be operated as an independent unit without any changes. In addition, it is planned that F. J. Lewis shall become a member of the board of directors of the International Engineering Corp., and will serve on the executive committee.

"The importance of the acquisition is not appreciated until one realizes the coal tar situation and the amount of coal tar which International Combustion may produce through the low temperature distillation of coal," said an officer of that company in a special interview.

Seeks Commanding Position

"The International company in this low temperature distillation work, has processes for both domestic and industrial fuels. At present, there are five plants in this country and abroad under contemplation with a daily consumption of 2,500 tons of coal. These will produce nearly 20,000,000 gal. of coal tar per year. The coal to be treated in those plants represents less than one-fourth of one per cent of the bituminous coal mined annually in the United States alone, most of which it is possible to distill. It is obvious that the International company, having its own coal tar distilling company and obtaining the full value of these tars, will greatly benefit and will be in a commanding position.

"The value of low temperature tars is acknowledged by those familiar with the art of tar distilling as being worth 50 to 100 per cent more than the tar obtained from high temperature ovens. A difference of two or three cents per gallon for the tars produced in the plants will be a very big figure."

Foster Wheeler Corp. Formed by Consolidation

Formation of the Foster Wheeler Corp. brought about recently by the consolidation of the Power Specialty Co., 111 Broadway, New York City, and the Wheeler Condenser & Engineering Co., 149 Broadway, New York City, was made known July 19.

The assets, plants, engineering, research, sales departments and subsidiaries of both companies will now be assembled under one corporate identity to be known as the Foster Wheeler Corp. No changes in products are contemplated, as there has been no competition or overlapping of effort in the past. The products of each company complemented those of the other, but there is the great advantage that both were sold to the same industries and often to the same customers.

The most widely known products of these companies are superheaters, economizers, water-cooled furnaces, air heaters, tube stills, unit coal pulverizers, condensers, pumps, cooling towers, feedwater heaters, evaporators, fractionating equipment and heat exchangers. These are built at Dansville and Newburgh, N. Y., at Cartaret, N. J., St. Catharines, Ontario, Canada, and at Egham, Surrey, England.

No Change in Management

The companies have branch offices throughout this country and subsidiaries in Canada and Europe. Thus the combination of departments will effect valuable economies and the increased plant facilities with greater volume and buying power are certain to result in desirable savings, according to announcement.

No change in management will be made, and former conservatism coupled with most advanced research and engineering will be maintained. The new officers will be those of the old companies as follows: J. J. Brown, chairman of the board of directors; Pell W. Foster, vice-chairman and treasurer; L. B. Nutting, president; John Primrose, vice-president; H. S. Brown, vice-president; W. E. Dowd, Jr., vice-president; David McCulloch, secretary and general manager; W. F. Keenan, Jr., chief engineer.

The new corporation will have no securities prior to 35,000 shares of preferred stock and 194,000 shares of no par value common stock. The combined assets are approximately $12,000,000.

Delay on St. Lawrence Seaway Required by Canada

Because of diverse opinion held by the joint board of Canadian engineers, the long mooted proposal that the governments of Canada and the United States confer on the suggested seaway through the Great Lakes and St. Lawrence River cannot be taken up at this time by the Dominion authorities, it was disclosed July 15 in an exchange of notes made public at the State Department.

Canada asks postponement of completing the project until further engineering data are furnished by the Canadian advisory commission.

In a note handed to the Canadian Minister, Vincent Massey, by Secretary of State Kellogg April 13, Canada was informed of this government's readiness to begin negotiation for a treaty or convention covering the joint cost of constructing the proposed waterway. In Canada's answer, transmitted July 12 by W. L. MacKenzie King, Prime Minister, the point is made Canada's study of the question is incomplete. At a later date the Dominion authorities will be prepared to take the subject up, he says.

Alternative Plans Pending

Asserting that "for more than 100 years the Great Lakes and the St. Lawrence River have furnished a common highway and transportation outlets," Secretary Kellogg reviews the studies made by American and Canadian authorities on navigation facilities of the St. Lawrence River between Montreal and Lake Ontario so as to transform that section into an ocean seaway.

"The government of the United States adopts the recommendations of the St. Lawrence Commission," the Kellogg note said. "It appreciates the advantages which will accrue equally to both countries by the opening of the waterway to ocean shipping.

"This government is prepared to enter into negotiations with a view to the formulation of a convention appropriate to this subject and should be grateful to be informed of the views entertained on this subject by your government."

In his reply, Prime Minister MacKenzie King makes the point that the report of the joint board of engineers, while unanimous in many respects, indicated differences of opinion on important phases of the development proposed, and asserts that in appendixes to the report, now in preparation, "certain further alternative schemes will be presented which will be of essential value in arriving at a conclusion.

Popular League Fights Permit to Potomac River Corp.

Protest against the granting of the application of the Potomac River Corp. for a preliminary permit has been filed with the Federal Power Commission by the National Popular Government League, Washington, D. C., an organization advocating government ownership of utilities.

"Since the people in the District of Columbia," says the communication, "have no organized corporate body and can express themselves only through their citizens' foundations and associations, we urge upon your Commission the necessity of securing a referendum upon this question before action is taken.

"This great natural property is the greatest asset of the nation's capital and its residents. In the years to come its value to the people of the District of Columbia will become an increasing factor in their daily lives. The Federal Power Commission can, and should, afford to go slowly in granting away this inestimably valuable privilege. The preliminary permit is clearly a first step in leasing this power for fifty years to a private corporation. We hold that the City of Washington should be a model in the new art of beauty by electric lighting as is indicated by the City of Seattle and the plan for the new capital of the Commonwealth of Australia."

In sending out a copy of the letter to the press the League enclosed a bulletin by Judson King, its director, in which he attempts to show the savings which would come to the residents of the District of Columbia were their power furnished by a publicly owned plant, as is the case in Tacoma, Wash. Bills for electric current in Washington are compared with those in Tacoma.

N. Y. Edison Purchases Frequency Changers

Announcement has been made by the New York Edison Co. of the purchase of a large steam turbine-generator unit to be installed in its East River station.

The unit will be rated at over 210,000 hp., and is said to be the largest single turbine-generator being manufactured in the world. It will consist of a single generator driven by a tandem compound steam turbine. At the same time two 40,000-kw. frequency changer sets of the synchronous induction type were ordered. Both the turbine unit and frequency changers will be manufactured by the General Electric Co. at Schenectady, N. Y.

Power Project Proposed on Arkansas River

The Public Service Co. of Colorado, Denver, has made application to the Federal Power Commission for a preliminary permit for a project in the "Royal Gorge" of the Arkansas River, near Canon City, Colo., the Commission stated orally on July 19. The plant would be located on public lands.

The project would consist of a diversion dam creating a pond of 529 acre-ft. capacity, a conduit and tunnel leading into a forebay of 1,923 acre-ft. capacity, a penstock to a power house with an installed capacity of 33,000 hp. and a power capacity of 16,000 horsepower.

Paul O. Reyneau Joins Cutter Electrical Company

Paul O. Reyneau has just affiliated himself with the Cutter Electrical & Manufacturing Co. of Philadelphia, Pa. Due to his long experience both in engineering and operating with electric light and power companies and his consequent knowledge of their problems, he will devote the major portion of his time

PAUL O. REYNEAU

to developing applications for air circuit breakers in the utility field.

For the past 3½ years he has been consulting engineer for the American Gas Co., Philadelphia, remaining with that organization until its recent merger with the United Gas Improvement Company.

Mr. Reyneau's first electrical work was as an employee of the Telluride Power Co. and he spent four years in the West, engaging in the operation and construction of plants and transmission lines. He then continued his technical education at Cornell University, from which institution he was graduated in 1913. Immediately after graduation he became identified with the overhead lines department of the Detroit Edison Co., subsequently serving as distribution engineer and still later as assistant electrical engineer, holding the last named position until his resignation to become affiliated with the Philadelphia Electric Co. in charge of transmission and distribution design. It was in 1923 that he joined the American Gas Company.

Mr. Reyneau has been active in association work, being a member of the American Institute of Electrical Engineers and having served as a member of the apparatus committee and of the overhead systems committee of the National Electric Light Association.

Arthur A. Hamerschlag, Head of Research Corp., Dies

Dr. Arthur Arton Hamerschlag, president of the Research Corporation of New York manufacturing among other products Cottrell electrical precipitators, and former president of the Carnegie Institute of Technology at Pittsburgh, died at Roosevelt Hospital, New York City, July 20, following an intestinal operation. Dr. Hamerschlag was fifty-four years old.

His work in developing Carnegie Institute from little more than a trade school and his introduction of numerous educational reforms brought Dr. Hamerschlag recognition as one of the leading educators of the world.

Born in New York City, Nov. 22, 1873, he received the degree of D.Sc. in engineering from both Lehigh University and Western University of Pennsylvania in 1907 and the degree of LL.D. from Trinity College, Conn., in 1912 and from Allegheny College, Pa., in 1915. After engaging in engineering work in the field in this country, Cuba and Mexico for four years, Dr. Hamerschlag became superintendent of St. George's Evening Trade School here, which was sponsored by the elder J. P. Morgan.

In 1903 Andrew Carnegie called him to the presidency of Carnegie Institute, a position which he filled with distinction until 1922. He became a close friend of Mr. Carnegie and was one of a group to whom the steel man bequeathed life annuities.

In Industrial Research

Dr. Hamerschlag was director of industrial research in the office of Major General George W. Goethals during the war and in 1923 assumed direction of the work of the Research Corporation, an inventors' clearing house organized in 1912 under the auspices of the Smithsonian Institution of Washington.

He was a member of the Schenley Memorial Commission, the Pittsburgh Chamber of Commerce, the American Association for the Advancement of Science, the American Federation of Arts, the Society for the Promotion of Engineering Education and the Engineers' Society of Western Pennsylvania. He was a member of the Duquesne Club, Pittsburgh Athletic Club and the City Club of New York.

Mathematical Symbols Ready for Approval

Embodying the work of one of the nine subcommittees on scientific and engineering symbols and abbreviations, sponsored by the engineering societies, a proposed standard for Mathematical Symbols as developed by the subcommittee No. 6, headed by Edward V. Huntington, professor of mathematics, Harvard University, has appeared in printed form for distribution and review.

This proposed standard is now before the five sponsor bodies for approval and transmission to the American Engineering Standards committee.

Stoker Production 4 Per Cent Over Last Year

Stoker manufacturing plants of the country appear at present to be operating in a more stable manner than was reported last year. The last six months have apparently not witnessed the great swings in production that took place during the same period of 1926.

The monthly production this year has not varied by more than 7.5 per cent from the average monthly production for the period, while during the first half of last year the low point of production was 18 per cent under the monthly average and the peak of production was 20 per cent above the monthly average for the period. The volume of production by the stoker manufacturing plants during the first half of the present year was about 4 per cent over that of the same period last year.

Such is the picture of productive activity in the stoker manufacturing plants of the country as indicated by the consumption of electrical energy as reported monthly by a number of these plants to *Power*.

The first half of the year closed with the stoker manufacturing plants operating at the lowest rate of productivity witnessed during the last 15 months. Not since March, 1926, has stoker production reached such a low point. The June production was in excess of that reported for May, but the rate of production is found to be 0.7 per cent under May after corrections are made for the number of working days in the two months. The June production was 16.2 per cent under June of last year and was 10.7 per cent under last March, the peak month so far during the present year.

Position Better This Summer

Despite the fact that the present rate of stoker production appears to be considerably under that of the same time last year, the indications are that the industry is in a better position today than during the summer of last year. The actual production during the first half of the year has exceeded that of the same period of last year, the manufacturing plants have been operating at a fairly stable rate, probably closer to the most efficient rate, and the future holds unusual sales opportunities. The amount that the electric light and power companies of the nation will spend for new steam-plant equipment this year, as budgeted at the opening of the year, is $252,000,000, practically the same as for 1926. But the reports for the first five months of the year indicate that the marvelous growth that industry has witnessed since the War is still going forward at only a slightly reduced rate. The production of general manufacturing plants throughout the nation has continued at an unusually high rate even into the summer months, and the high purchasing power of the American people is indicative of the fact that this high rate of production is probably of a permanent nature. These economic conditions call for larger and more efficient power plants within the manufacturing establishments themselves or on the part of the public utilities in order that the necessary volume of commodities may be turned out to satisfy this increased demand by the people of the nation—a direct forecast of increased stoker requirements, as well as other power-plant equipment.

Some Results of Continental Steel Entente

As a part of their efforts at reduction in cost of production, the Germans have initiated a means for reducing cost and stabilizing industry, known as the cartel, which, in essence, is some type of co-operation, chiefly in selling, price agreement and in allotment of production quotas between manufacturers who are financially independent. The device is legal in Germany. It extends beyond German boundaries, and there are now a goodly number of international cartels. Of these international cartels the raw steel combination known as the Continental Steel Entente has attracted much attention during the past year.

Formation of Entente

The agreement creating the Continental Steel Entente was signed Sept. 30, 1926, by representatives of the steel industries of Germany, France, Belgium, Luxemburg and the Saar. The provisions went into effect Oct. 1, 1926. Later the Czechoslovak, Austrian and Hungarian steel industries adhered to the terms of the entente. Their actual participation commenced Jan. 1, 1927.

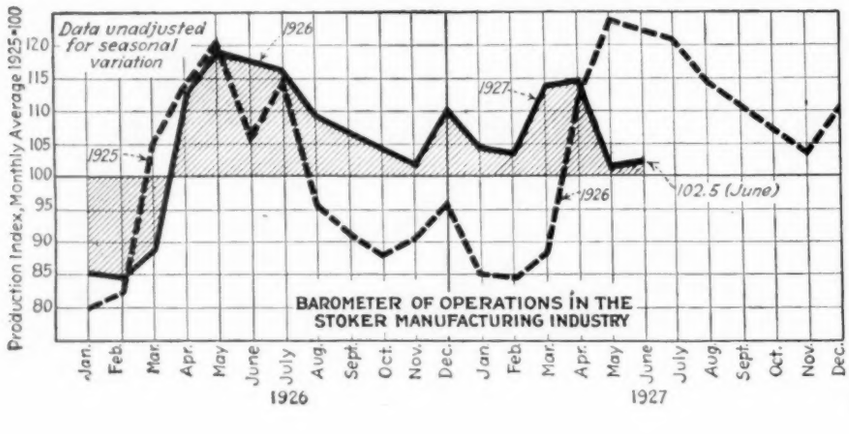
According to the agreement each country pays into a common fund one dollar each month for each ton of raw steel effectively produced. Each country is assigned a quota which is fixed quarterly by a committee consisting of four representatives of each of the participating countries. In order to make any change in the quota, a majority vote of three-fourths of the members is required. If the quarterly production of a country surpasses the quota set for it during any quarter, it is required to pay into the common fund $4 for every ton produced in excess of its allotment. If the production of any country falls below its quota, it receives $2 from the common fund for each ton in deficit of its quota, not to exceed 10 per cent of the tonnage allotted. According to the agreement the first liquidation of this fund, covering the first quarter's operation from Oct. 1, 1926, to Jan. 1, 1927, was made on April 1, 1927.

Germany Exceeds Tonnage

A study of the entente by the National Industrial Conference Board indicates that for this quarter the quota of the entire entente was set at 7,332,000 metric tons (a metric ton equals 2204.6 lb.) or at the annual rate of 29,287,000 metric tons. Of this quota 43.17 per cent was allotted to Germany, 31.19 per cent to France, 11.56 per cent to Belgium, 8.30 per cent to Luxemburg and 5.78 per cent to the Saar region. The actual production for the first quarter of operation was 7,922,000 metric tons. Three areas—Germany, Belgium and the Saar—exceeded their tonnage while France and Luxemburg failed to produce their quota. The total excess production of the three countries overproducing amounted to 696,000 metric tons, while the deficit for the two which did not reach their quota was 96,000 tons.

One Dollar Per Ton

According to the terms of the agreement the $1 charge and the $4 per ton fines both go into a common fund. This fund after payment of administrative expenses, which are small in proportion to the total collection, and the subsidies to countries which underproduce, is returned to each country in proportion to its quota. On this basis the $1 per ton charge amounts really to a deposit. The only real penalty which can be said to act as a restraint to overproduction is not the actual payment of the $4 fine, but the proportion of this which will be restrained due to the $2 subsidy for underproduction. As may be seen from the above table the penalty inflicted upon Germany and Belgium for overproduction amounted in the first quarter to about 40 cents and 10 cents a ton respectively. The comparative inability of any producer to forecast the actual rate at which this $4 per ton fine will be collected, apparently is the real restraining factor tending to keep the several members in line with the production program.


Production Index, Monthly Average 1925=100
Data unadjusted for seasonal variation
1926
1927
1925
1926
102.5 (June)
BAROMETER OF OPERATIONS IN THE STOKER MANUFACTURING INDUSTRY
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan Feb Mar. Apr. May June July Aug Sept. Oct. Nov. Dec.
1926
1927

Personal Mention

L. R. NICHOLS, formerly electrical superintendent of the Glens Falls district of the Adirondack Power & Light Corp., has been appointed electrical superintendent of the northern division of the corporation.

GUS F. TAYLOR was elected a member of the board of directors of the Texas Power & Light Co., at a recent meeting of the directors, John W. Carpenter, president of the Texas Power & Light Co., announced following the meeting. Mr. Taylor is president of the Citizens National Bank of Tyler, Tex.

H. J. G. RUDOLF, chief engineer of the Winslow Boiler and Engineering Manufacturing Company, Chicago, is in Galesburg, Ill., in charge of the Galesburg branch of the firm following the resignations of R. D. DeWolf and H. A. Tedman, superintendent and factory manager. The plant is producing oil burners and has opened a new research department in charge of L. P. Arms, Chicago.

F. W. KELLIGREW, who has been associated with the New York Section of the American Society of Refrigerating Engineers for a number of years, was recently elected to assume the duties of treasurer of that society at a recent meeting of the officers. Mr. Kelligrew succeeds in this position the late Charles T. Drake, who died June 5.

FREDERICK M. FISK on July 1 because manager of the Pacific Coast office of McIntosh & Seymour Corp., 815 Sheldon Bldg., San Francisco. Mr. Fisk was formerly connected with various engineering enterprises and has had extensive Diesel engine experience in the McIntosh & Seymour plant in Auburn, N. Y.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

Canadian Steel and Power Show and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Business Notes

THE BONNEY FORGE & TOOL WORKS, Allentown, Pa., has appointed W. W. Wixson, who has been with the organization for quite a number of years, district sales manager of the central district.

THE UNION ELECTRIC MANUFACTURING CO., manufacturer of electric control apparatus of Milwaukee, Wis., announces the opening of a district office for the states of Louisiana and Mississippi, at 801 Tchoupitoulas St., New Orleans, La., to be in charge of G. P. Robbins and G. P. Robbins, Jr.

WARREN WEBSTER & COMPANY, manufacturers of Webster Systems of steam heating, have acquired the inventions of James A. Donnelly and the physical assets of the Donnelly Systems Co., New York City. The business of the Donnelly Systems Co. has ben liquidated. Orders for repairs and replacements to existing installations of Donnelly Systems will be taken care of from the home office of Warren Webster & Co., Camden, N. J.

Trade Catalogs

WATER TREATMENT IN ICE MANUFACTURE—The International Filter Co., 333 West 25th Place, Chicago, recently published Bulletin 2005—"Why Water Treatment is Necessary in the Manufacture of Ice." By taking several analyses of actual waters and picturing (in four colors) the quality of ice that will be produced with and without treatment, an attempt has been made to visualize the quality of ice that can be expected from various waters.

STEAM TURBINES—The Dean Hill Pump Co., manufacturers of pumping machinery and steam turbines, Anderson, Ind., has issued bulletin No. 1202. This bulletin describes in detail the various features of design of wait type steam turbines, the construction of which is adapted for modern central station work where high pressure and temperature steam is used. Pages 12 to 14 inclusive are devoted to some useful engineering data relative to determining the approximate water rates and also correction factors due to superheat and back pressure.

INDICATOR RECORDERS.—The C. J. Tagliabue Manufacturing Co., 18-88 Thirty-third St., Brooklyn, N. Y., in bulletin No. 942 deals with the application of Tag-Mono indicator-recorders to boiler furnaces of stationary power plants.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	July 13, 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.70
Clearfield	Boston	1.50@ 1.75
Somerset	Boston	1.60@ 1.95
Kanawha	Columbus	1.25@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	1.90@ 2.15
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky	Louisville	1.50@ 1.60
S. E. Ky	Louisville	1.40@ 1.60
Big Seam	Birmingham	1.50@ 2.15
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.50@ 3.00
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	1.25@ 1.60

FUEL OIL

New York—July 21, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—July 14, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.526c. per gal.; 38@40 deg., 5.23c. per gal.

Pittsburgh—July 13, f.o.b. local refinery; 30@34 deg., fuel oil, 4⅜c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—July 14, 27@30 deg., $2.20½@$2.26½ per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—July 12, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—July 21, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.00; 30@32 deg., $1.10.

Boston—July 18, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal.; 28@32 deg., 5.9c. per gal.

Dallas—July 19, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

NEW PLANT CONSTRUCTION

Calif., Los Angeles—Embassy Holding Corp., awarded contract for the construction of a 13 story hotel at 960 West 6th St. to Arthur Bard & Co., Pacific National Bank Bldg. Estimated cost $500,000.

Steam heating, refrigeration and ventilation systems, 2 electric elevators, etc., will be installed.

Calif., Los Angeles—Goodrich Rubber Co., Akron, O., awarded contract for the construction of a factory including power house, engine rooms, etc., on Mines Ave., to The Foundation Co., 120 Liberty St., New York, N. Y. Estimated cost $5,000,000.

Calif., Los Angeles—University of California, is having plans prepared for the construction of a group of college buildings including steam heating system, etc. on Westwood Campus. Estimated cost $1,200,000. Allison & Allison, Hibernian Bldg., are architects.

Conn., West Hartford (Hartford P.O.)—St. Thomas Seminary, M. F. McAuliffe, had plans prepared for the construction of a seminary including central heating plant, refrigeration and ventilation systems, boilers, elevators, etc. on Bloomfield Rd. Estimated cost $1,000,000. L. A. Walsh, 51 Leavenworth St., Waterbury, is architect.

Massachusetts—Marlboro Electric Light Co., R. H. Jamesson, Mgr., 150 Congress St., Boston, plans the construction of two transformer stations, one at Northboro and one at Berlin. Private plans.

Mass., Boston—Hospital Dept., Harrison Ave., will soon award contract for the construction of addition to boiler room and power house on Albany St. Ritchie, Parsons & Taylor, 15 Ashburton Pl., are architects. R. D. Kimball & Co., 6 Beacon St., are engineers.

Mass., Cambridge (Boston P. O.)—Radcliff College is receiving bids for the installation of a heating system in college buildings. Estimated cost $25,000. French & Hubbard, 210 South St., Boston, are engineers.

Mass., East Walpole—Bird & Sons Inc., awarded contract for the construction of addition to turbine room to J. Gascoigne & Co., 6 Beacon St., Boston.

Mich, Detroit—Stott Realty Co., 409 Lincoln Bldg., having plans prepared for the construction of 35 story office building, including steam heating, elevators, etc., at State and Griswold Sts. Donaldson & Meier, Penobscot Bldg., are architects.

Minn., Minneapolis—Estate Building Co., W. Wolfson, 3151 Girard Ave. plans the construction of a 12 story hospital including steam heating system, etc. at 10th St. and 3rd Ave. S. Estimated cost $1,500,000. C. J. Bard, 838 Builders Exchange Bldg., is architect.

Mo., California—City plans the construction of a power plant and pump house. Architect and engineer not selected.

Mo., Kansas City—Schmidt, Garden & Erickson, Archts., 104 South Michigan Blvd., Chicago, Ill., are preparing plans for the construction of a hospital, at 50th St. and Troots Ave. Estimated cost $1,000,000. Owner's name withheld. Greenbaum, Hardy, Schumaker, 206 Scarrett Bldg., Kansas City, are associate architects.

N. H., Durham—University of New Hampshire, awarded contract for the construction of a heating plant, to S. Belanger & Son Inc., 308 Main St., Nashua. Estimated cost $39,748.

N. J., Jersey City—D. Lerner, 21 Gifford Ave., had plans prepared for the construction of 10 story apartment, including steam heating, elevators, etc., at 88 Gifford Ave. Estimated cost $1,500,000. Private plans.

N. J., Newark—Five Hundred Mount Prospect Avenue Corp., Broad St., awarded contract for the construction of an 8 story apartment building at 523 Mount Prospect Ave., to W. J. MacEvoy Constr. Co., 85 Academy St. Estimated cost $500,000.

N. Y., Scarsdale—Equity Scarsdale Corp., 285 Madison Ave., New York, is having plans prepared for the construction of a 4 story hotel including ventilation system, elevators, swimming pool, etc. at Crane Rd. and East Parkway, here. Jardin, Hill & Murdock, 347 Madison Ave., New York, are architects.

N. Y., White Plains—Westchester County Sanitary Sewer Comn., E. S. Martin, Secy., 192 Martino Ave., will receive bids until Aug. 8 for the construction of a pumping plant, etc., for Blind Brook project.

O., Akron—Good & Wagner, Mohawk Bldg., Archts. and Engrs., will receive bids about Sept. 1 for the construction of an 8 story addition to hospital including steam heating system, etc. on East Market St. for City Hospital. Estimated cost $800,000.

O., Cleveland—Crowell & Littel Constr Co., c/o R. H. Cobb, Secy. and Treas., 935 Hanna Bldg., having plans prepared for the construction of 12 story hotel, on Euclid Ave., near East 90th St. Estimated cost $750,000. Ellerbe & Co., 692 Endicott Bldg., St. Paul, Minn., is architect.

O., Cleveland — The Great Western Oil Co., B. W. Browne, Pres., 2846 East 37th St., had plans prepared for the construction of a factory and boiler house, etc., on East 37th St. Estimated cost $100,000. F. F. Hodges, Hickox Bldg., is architect.

Ore., Eugene — City voted $1,250,000 bonds for a water and power development from the McKenzie River.

Pa., Allentown—Allentown Hospital Association, F. B. Bernerd, will receive bids until July 27 for the construction of a 6 story hospital at 17th and Chew Sts. Ruhe & Lange, 12 North 6th St., are architects.

Tex., Alice—City, F. W. Hobbs, Mayor, awarded contract for waterworks improvements including drilling of well, pumping equipment, etc. to Layne & Bowler Co., Chelsea Ave., Memphis, Tenn. Estimated cost $16,000.

Tex., Cuero—City plans an election Aug. 23 to vote $14,000 bonds for waterworks improvements including pumping equipment, mains, etc.

Tex., Laredo—Central Power & Light Co., S. M. Udden, Pres., Frost Bldg., San Antonio, will soon award contract for waterworks improvements including filtration plant and pumping station, etc. here. Alvord, Burdick & Howsen, Laredo, are engineers.

Tex., Port Lavaca—Bayside Beach Inc., 304 Texas Bldg., San Antonio, awarded contract for the construction of a hotel here to B. & B. Construction Co., 884 Rush St., Chicago, Ill. Estimated cost $700,000.

Steam heating and ventilation systems, boilers, elevators, swimming pool, etc. will be installed.

Tex., San Antonio—B. W. Mills, Philadelphia, Pa., or F. H. Booth, Frost Bldg., San Antonio, Tex., are having plans prepared for the construction of a waterworks system including pumping unit mains, etc. Estimated cost $45,000. Private plans.

Tex., Shamrock—Central Power & Light Co., Frost Bldg., San Antonio, plans the construction of a power plant, 800 hp. capacity here. Estimated cost $40,000. Private plans. Machinery will be required.

Wash., Seattle — Exeter Co., Skinner Bldg., awarded contract for the construction of a 14 story apartment at 8th and Seneca Sts. to H. F. Allan, Green Bldg. Estimated cost $1,000,000.

Wis., Wauwatosa—County of Milwaukee, W. Coffey, Mgr. County Institutions, plans the construction of a hospital. Estimated cost $2,000,000. Van Ryn & De Gelleke, 114 Wisconsin Ave., Milwaukee, are architects.

British Columbia — Canadian National Railways, Montreal, Que., plans the construction of a new ice plant at Prince Rupert, also extensions and improvements to ice storage plant at Kamloops, here. Estimated cost $50,000. S. J. Hungerford is chief engineer.

Ont., Oshawa — General Motors Co. of Canada, awarded contract for the construction of an automobile factory to Jackson Sewer Construction Co., Federal Bldg., Toronto. Estimated cost $750,000. Steam heating system, etc., will be installed.

Ont., Teeswater — Town plans the construction of a new waterworks system including reservoir, pump house, pumping equipment, etc. Estimated cost $35,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

Ont., Toronto—Casa Loma, Austin Terrace, having plans prepared for the construction of 7 story apartment hotel, addition, including steam heating, elevators, etc. Estimated cost $750,000. W. F. Sparling, Metropolitan Bldg., is architect.

Ont., Toronto—Garden Apartments, c/o N. A. Armstrong & Co., Ltd., 7 King St. E., is having plans prepared for the construction of a 12 story hotel including steam heating system, elevators, etc., at Carlton and Sherbourne Sts. Estimated cost $1,500,000.

Ont., Toronto—Ramsey, Stewart & Co., Northern Ontario Bldg., will soon receive bids for the construction of a 15 story hotel including steam heating system, elevators, etc. at Bloor St. and Avenue Rd. Estimated cost $2,000,000. H. G. Holman, Northern Ontario Bldg., is architect.

Equipment Wanted

Boiler, Etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the installation of a 300 hp. water tube boiler, etc. in Naval Operating Base (Hospital), San Diego, Calif.

Electrical Equipment—Transit Dept., T. F. Sullivan, Chn., Boston, Mass., will receive bids until July 27 for electrical equipment for Ashmont Station, Dorchester Rapid Transit. Estimated cost $10,000.

Engine and Generator—City of Amory, Miss., will receive bids until August 2 for a Diesel oil engine and generator.

Generator and Compressor Units—W. L. Walters, Clk., Gastonia, N. C., will receive bids until July 29 for furnishing and installing a gas engine driven generator unit and motor driven compressor unit for proposed improvements to sewage disposal plant and power house, etc.

Pump and Motor—City of Knowles, Okla., will be in the market for deep well pump and motor for proposed waterworks system. Estimated cost $20,000.

Pump and Motor—City of Maud, Okla., is in the market for a 50 g.p.m. deep well pump and 5 hp. motor.

Pump and Motor—Contra Costa County Waterworks Dist. No. 1, Martinez, Calif., will receive bids in Aug. for furnishing and installing pump and motor, etc.

Pump and Motor—La Canada Irrigation Dist., La Canada, Calif., will receive bids until Aug. 2 for furnishing and installing one 125 g.p.m. multi-stage centrifugal pump, 280 ft. head direct connected to motor.

Pumping Units—Dept. of Public Works, City Hall, Detroit, Mich., will receive bids until July 28 for four vertical electric motor driven pumping units, 500 cu.ft. capacity with auxiliary equipment.

Pumps and Motors—Common Council, H. H. Hammans, Clk., Martinsville, Ind., will receive bids until Aug. 1 for furnishing and installing one 3 in., 350 g.p.m. three stage centrifugal pump direct connected to 40 hp., 3 ph., 60 cycle, 220 v. 1,800 r.p.m. slip ring type motor, one 5 in. 650 g.p.m. single stage horizontal centrifugal pump direct connected to 75 hp., 3 ph. 60 cycle, 220 v. 1,800 r.p.m. slip ring type motor, and one 5 in. 1,000 or 1,200 g.p.m. single stage horizontal centrifugal pump direct connected to 100 hp. 3 ph., 60 cycle, 220 v. 1,800 r.p.m. slip ring type motor.

Turbine, Etc.—F. H. Uhler, 1332 Montrose Ave., is in the market for a small water turbine, etc. for proposed power dam.

Turbine, Equipment, Generators and Condensers — Oklahoma Gas & Electric Co., Hanna, Okla., plans the installation of steam turbine equipment, generators and condensers, etc., to increase the capacity of present power plant 35,000 kw. Estimated cost $400,000.